Taxonomic revision of the South African mealybug genus *Octococcus* Hall (Hemiptera: Pseudococcidae)

D.R. Miller[1] & J.H. Giliomee[2*]

[1]*Systematic Entomology Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland, U.S.A., and Department of Plant Industry, Gainesville, Florida, U.S.A.*
[2]*Centre for Invasion Biology, Department of Botany and Zoology, Stellenbosch University, Private Bag XI, Matieland, 7602 South Africa*

A taxonomic revision of the South African mealybug genus *Octococcus* Hall is presented. Most species of this genus feed on plants in the Asteraceae. Six species are treated, namely, *O. barbarae*, *O. gullanae*. and *O. warniae* which are described as new. The three previously described species are: *Octococcus africanus* (Brain), *O. minor* De Lotto, and *O. pentziae* Hall. *Octococcus salsolicola* (Priensner & Hosny), which was described originally as *Ripersia salsolicola*, is treated as a *nomen dubium*. Adult females of all species are described and illustrated and a key for their identification is presented. Illustrations and descriptions are also presented of first-instar nymphs of *Octococcus africanus*, *O. minor*, and *O. warniae* and a key for their identification is presented. Descriptions and illustrations are also given for a second-instar nymph of *O. africanus* and a third-instar nymph of *O. warniae*.

Key words: *Octococcus*, Pseudococcidae, mealybugs, immatures, new species, South Africa.

INTRODUCTION

Octococcus was described by Hall (1939) for *O. pentziae*, which he described as new, and for *Puto africanus* Brain, both from South Africa on plants in the daisy family (Asteraceae). Hall used the name '*octo*' for the eight setae associated with the anal ring, a character state that is atypical of mealybugs, which generally have six anal-ring setae. Hall recognised that the posterior pair was not a true anal-ring seta but thought that its close association with the anal ring was unusual enough to name the new genus *Octococcus* for the eight setae on or near the anal ring. The posteriormost setae are what Ezzat & McConnell (1956) called suranal setae. Earlier, Brain (1915) was persuaded that the four pairs of setae associated with the anal ring in combination with the presence of nine-segmented antennae were sufficient for him to place the species that is now *Octococcus africanus* (Brain) in the genus *Puto*. Ferris (1918) did not agree with this placement, but did not transfer it to another genus. *Puto africanus* was redescribed and reillustrated by De Lotto (1958) based on two poorly prepared type specimens. He described the species again (De Lotto 1977) based on better-prepared type specimens deposited in the Smithsonian's U.S. National Museum of Natural History and based on additional material collected in South Africa. In 1962 Ezzat transferred *Ripersia salsolicola* Priensner & Hosny to *Octococcus* based on examination of the only known specimen in The Natural History Museum in London. De Lotto (1969) described a fourth species in the genus (*Octococcus minor* De Lotto). He agreed with Williams (1958) and Hall (1939) that the extra pair of setae associated with the anal ring were not true anal-ring setae but pointed out that the unusual structure of the large-sized oral-rim tubular ducts warranted maintaining the genus as valid.

*Author for correspondence. E-mail: jhg@sun.ac.za

MATERIAL AND METHODS

Specimens are mounted in Canada balsam following the procedures described in McKenzie (1967). Illustrations were made using a camera lucida and are presented in the standard format for most modern scale insect papers with the ventral surface on the right half of the illustration and the dorsal surface on the left.

Letter designations on the illustrations are as follows: a = antenna, b = trilocular pore, c = small tubular duct, d = dorsal seta, e = lanceolate or conical seta, f = anal-lobe cerarius, g = anal ring, h = multilocular pore, i = leg, j = large tubular duct, k = discoidal pore, l = second cerarius, m = ventral seta, n = fourth cerarius, o = pores near hind coxae, p = unusual sclerotisation.

ISSN 1021-3589 [Print]; 2224-8854 [Online]
DOI: http://dx.doi.org/10.4001/003.024.0112

Descriptions are based on detailed examination of five specimens from as many different localities and hosts as possible. A significant portion of the specimens used in this study are deposited in the South African National Collection of Insects in ARC-Plant Protection Research Institute, Pretoria (SANC). We also studied material from The Natural History Museum, London, U.K. (BMNH) and the U.S. National Museum of Natural History, Beltsville, Maryland (USNM). Descriptions of new species include the character states of the holotype first, then those of the type series are given in brackets. The format for listing the number of slides, the number of specimens, and the various instars in the 'material examined' section is as follows: if there are two slides containing four adult female specimens the designation would be 2/4 ad. fem.; if there are two slides containing two adult female specimens, two first-instar nymphs, and two first-instar nymphs that are moulting to second-instar nymphs the designation would be 2/2 ad. fem., /2 first instar /2 moulting first instar to second. We also have used several short-cut designations for structures that are frequently used in the descriptions, *i.e*. oral rims for oral-rim tubular ducts; segment VII for abdominal segment VII and similar terminology for other abdominal segments. Plant names are given according to Plants of Southern Africa: an online checklist:
http//posa.sanbi.org.

RESULTS

Octococcus Hall, 1939

Type species *Octococcus pentziae* Hall (original designation); Morrison & Morrison, 1966: 137; Afifi & Kosztarab, 1967: 11; Afifi, 1968: 151; De Lotto, 1969: 16, 1977: 30; Ben-Dov, 1994: 258; Millar 2002: 201; Hardy *et al*. 2008: 58.

Diagnosis. Adult female with dorsal setae enlarged at least posteriorly, some species with setae conical or lanceolate, others with setae only slightly enlarged; anal-lobe sclerotisation and anal-lobe cerarius fused [most mealybug species possess a ventral anal-lobe sclerotisation that is separate from the sclerotisation of the dorsal anal-lobe cerarius, but in fully mature specimens of *Octococcus* species the anal-lobe area is present on the dorsum and is attached to or fused with the anal-lobe cerarius]; anal-lobe sclerotisation on dorsal surface rather than at posterior apex of abdomen in mature females; no more than five pairs of cerarii, usually two; without a circulus; oral-rim tubular ducts of two or three sizes, larger size distinct, barrel-shaped with thin heavily sclerotised rim, inner ring present about half to two-thirds length of duct from dermal opening; all tubular ducts with a rim, oral-collar tubular ducts absent; antennae and eyes often on dorsum in fully mature females; eyes large, about same size as length of second antennal segment; some of setae on coxa, trochanter, and femur noticeably larger than other leg setae; setae on anterior margin of basal antennal segments larger than other antennal setae; digitules on front tarsus usually with one enlarged, capitate seta and one either long or short seta, not capitate; anterior ostioles usually absent; discoidal pores uncommon or absent; trilocular pores uncommon, usually most abundant in cerarii, on dorsomedial areas of posterior abdominal segments, and near spiracles; body of mature female rotund; body colour in alcohol dark blue-black; forming heavy, white waxy sac that covers body of adult female and apparently covers body of immature instars excluding first-instar nymph; first-instar nymph with seven-segmented antennae; immature instars of both sexes apparently with oral-rim tubular ducts, excluding first-instar nymph.

Notes. *Octococcus* is considered to be part of the tribe Trabutinini according to Hardy *et al*. (2008). There is a diverse array of genera included in the tribe. We have examined adult female specimens and descriptions of most of these genera and also have examined a number of first-instar nymphs. Interestingly, the seven-segmented antennae of the first-instar nymphs of *Octococcus* appear to be unique within the Pseudococcidae. We looked at the first-instar nymphs of several other members of the Trabutinini based on Hardy *et al*. (2008) (including *Amonostherium* Morrison & Morrison, *Antonina* Signoret, *Balanococcus* Williams, *Nipaecoccus* Sulc, *Melanococcus* Williams, *Miscanthicoccus* Takahashi, and *Peridiococcus* Williams, but found none that had seven-segmented antennae. *Puto* first-instar nymphs within the Putoidae also have seven-segmented antennae (Miller & Miller 1993).

Octococcus and *Trabutina* Marchal are similar by having a reduced number of cerarii, conical or lanceolate setae on the posterior dorsum of the abdomen, and some setae on hind coxa, trochanter, and femur larger than other leg setae. *Octococcus* differs (character states given in brackets are those of *Trabutina*) by normally lacking anterior ostioles

(present in *Trabutina*); having normal eighth abdominal segment (enlarged); few long setae around anal ring (many); complete anal ring (incomplete); clubbed tarsal digitules (simple); oral-rim tubular ducts present (absent); oral-collar tubular ducts absent, replaced by oral rims (present). *Octococcus* also is similar to *Hypogeococcus* Rau in the adult female by having a reduced number of cerarii; conical or lanceolate setae on the posterior dorsum of the abdomen; eye normally located on the dorsum; and setae on the anterior margin of the antennae are enlarged. *Octococcus* differs (character states given in brackets are those of *Hypogeococcus*) by having trilocular pores (usually absent); anterior ostioles usually absent (present); anal ring of normal size for a pseudococcid (greatly enlarged); and circulus absent (usually present). *Octococcus* also is similar to *Hypogeococcus* (Miller 1983) and *Trabutina* (Danzig & Miller 1996) in the immature instars by having tubular ducts on all but the first instar.

Newly moulted adult females of *Octococcus* are surprisingly small; many of the specimens studied were of a size that in most mealybugs would be immature. Immature stages were difficult to locate in the field, at least when collecting *O. warniae* at two different times of the year. Based on this evidence, we suspect that female specimens of *Octococcus* develop to adults very quickly.

It is unclear exactly when the thick white sac is formed, but it appears that at least the second- and third-instar females and second-instar males develop this sac, in addition to the adult female. We suspect that the oral-rim tubular ducts are important in the formation of the sac and since they occur in all but the first instar, this is supporting evidence for the sac-forming hypothesis in the immatures. Species of both *Hypogeococcus* and *Trabutina* also possess tubular ducts in the immature stages excluding the first-instar nymph and most likely also produce a wax covering similar to the adult female. It is likely that other members of the Trabutinini have similar habits and morphology.

In most pseudococcids the second-instar male can be distinguished from other immature instars by having tubular ducts present at least on the dorsum. These ducts are important in forming the sac that encloses the second-instar male, prepupa, and pupa during their development. In the case of *Octococcus*, we have been unable to find differences in the second-instar males and females. Unfortunately, we have a small series of second-instar nymphs but all have conspicuous tubular ducts arranged in a similar pattern. We have examined seven specimens from two localities collected at different times of the year that are in the process of moulting from the first to second instar and all seem to possess the same arrangement of tubular ducts. It is possible, but unlikely, that all of the second-instar specimens examined are male.

Octococcus africanus (Brain), Figs 1–4, Plate 1

Puto africanus Brain, 1915: 151 (original designation); Ferris, 1918: 62; De Lotto, 1958: 115.

Octococcus africanus; Hall 1939: 93 (change of combination); Afifi 1968: 151 (misidentification of *O. minor*; we have examined adult females associated with the males described by Afifi and conclude that they are representatives of *O. minor*); De Lotto 1977: 30; Ben-Dov 1994: 258; Millar 2002: 201, 219; Hardy *et al*. 2008: 57 (partial misidentification; Hardy *et al*. accepted the incorrect determination of the adult male of Afifi (1968) and used the characteristics of the adult male in their character matrix; the character states given for the adult female and first-instar nymph pertain to *O. africanus*).

Type material. The original description does not mention a type or holotype, so a lectotype is here designated. We have selected as lectotype an adult female mounted on a slide with one other adult female (specimen nearest slide label is the lectotype) that was labelled as 'Paratypes' by Brain. Left label '*Puto africanus* Brain/ on *Tamarix articulata*/ Vahl./ Cape Town./ Jan. 1898./ -Paratype-'. Right label under separate small slide cover '1–2'and under large slide cover 'B. 70. C. K. B.' A 'Lectotype' label has been placed on the slide, which is deposited in SANC. In addition there are three other paralectotype slides in SANC each containing one adult female, and four paralectotype slides are in USNM, two containing two adult females and two containing one adult female. All specimens are from the same series.

Additional material examined. SOUTH AFRICA: Northern Cape: Kamiesberg, NW of Doornkraal, Langkloof Pass, 30°32'S 18°08'E, 750 m, on *Elytropappus rhinocerotis*, 7.x.2005, P.J. Gullan, 4/4 ad. fem. (SANC); Western Cape: Albertinia, on *Stoebe vulgaris*, 9.iii.1970, P. Insley, 7/7 ad. fem. (SANC 4123 1–7); Bonnievale, Merwespont Farm, on *E. rhinocerotis*, 12.ii.2006, J.H. Giliomee, 3/3 ad. fem. (SANC); Cederberg Mountains, 1.5 km S. of

Sneeuwkop, 32°56′S 19°27′E, 1000 m on *Stoebe intricata*, 4.iii.2007, P.J. Gullan, 2/2 ad. fem., /2 first instar, /2 moulting first instar to second (SANC); Cederberg Mountains, Middelberg Pass, above Elandskloof Farm, on *Elytropappus* sp., 22.x.2004, N. Bergh, 7/5 ad. fem., /21 first instars (SANC); 37 km ENE Ceres, Klondyke Cherry Farm, on *E. rhinocerotis*, 28.xii.2004, P.J. Gullan, 6/4 ad. fem., /19 first instars/1 moulting first instar to second (SANC); De Doorns, on *E. rhinocerotis*, 8.x.1968, V.B. Whitehead, 7/7 ad. fem. (SANC 4380-2 to 4, -6 to -10); Du Toit's Kloof, on *Stoebe plumosa* stem, 9.i.2004, P.J. Gullan & J.H. Giliomee, 7/2 ad. fem. /25 first instars, /5 moulting first to second, /3 second instars (UCD), 5/3 ad. fem. /14 first instars, one moulting first to second (SANC); Klein Swartberg, on *E. rhinocerotis*, 8.ii.1961, H.D. Brown, 1/1 ad. fem. (SANC 650-1); Rawsonville, 10.iii.2014 on *E. rhinocerotis*, N. Landman & J.H. Giliomee, 1/1 ad. fem. (FSCA); Stellenbosch, on *E. rhinocerotis*, 15.vi.1931, collector ?, 1/4 ad. fem. (USNM).

Field characters. From Brain (1915) 'Adult ♀ enclosed in a dense felted or papery sac, which is generally white or yellowish in colour. Many of the sacs, in the dry material at hand, are broken at one end, and appear as white caps attached to the stems of the host-plant. The sacs, when not deformed by massing together, are regularly elongate oval about 2 mm. long and 1.2 mm. in diameter. The large number of small slender sacs beneath the larger ones suggests that either the younger ♀ form inhabits a sac, or that large numbers of males are produced.' Brain also indicated that the adult female turns deep black then dark green in NaOH.

Adult female (Figs 1, 2; Plate 1)

Slide-mounted characters. Mounted 1.2–3.5 mm long, 0.6–2.6 mm wide.

Dorsum. Body greatly enlarged; posterior segments folded on slide-mounted specimens so that anal ring and anal lobes positioned anterior of posterior apex of body; cerarii not near body margin, displaced medially; anal-lobe area placed on dorsal surface rather than normal position on venter. With two pairs of cerarii, occasionally with one or two conical seta in third cerarius area without associated trilocular pores or basal sclerotisation; anal-lobe cerarius sclerotised, on prominence, with two or three conical setae, one to five auxiliary setae, cluster of five to 15 basal trilocular pores. Penultimate cerarius in line with anal-lobe cerarius, weakly sclerotised, with two or three conical setae about same size as anal-lobe conical setae, zero to two auxiliary seta, and basal cluster of four to 14 trilocular pores. Without additional cerarii. Anal-lobe area sclerotised, contiguous with anal-lobe cerarius, with six to nine setae, longest about 130–235 μm long. Suranal setae near apex of abdomen, with four to seven setae, including two setae closely associated with anal ring. Discoidal pores uncommon, sometimes scattered over surface, most abundant near anterior margin of posterior abdominal segments. Trilocular pores uncommon, becoming less abundant anteriorly, most abundant in cerarii and near base of dorsomedial conical setae. Oral rims of two or three sizes: larger size distinct, with thin, heavily sclerotised rim, most abundant posterolaterally on posterior abdominal segments, usually absent medially on segments VI and VII, scattered elsewhere, uncommon on head, with five to 11 ducts on segment IV; smaller size with broad rim and narrow tube, abundant over surface. Lanceolate setae present in medial areas of segments III, IV, or V–VII, about same size as cerarian setae, distributed in rows, not forming medial cerarii, longest conical seta on segment VI 12–23 μm long, with nine to 16 setae on segment VI between lateral margins of posterior ostioles. Body setae of one variable size, longest setae near posterior end of abdomen, longest seta on segment VII 30–60 μm long, with nine to 23 setae on segment VI between lateral margins of posterior ostioles. Longest anal-ring seta 68–168 μm long, 1.0–1.7 times width of anal ring. Posterior ostioles small and inconspicuous, with zero to four loosely associated trilocular pores on anterior lip; anterior ostioles often present, inconspicuous. Eye diameter about same size as length of second antennal segment, usually located on dorsum along with antenna.

Venter. Vulva located near posterior apex of abdomen in fully mature specimens. Multilocular pores present from head, prothorax or mesothorax to posterior apex of abdomen, submarginal pores present or absent. Trilocular pores uncommon, scattered over surface, most abundant in lateral areas of anterior abdominal segments, thorax and near spiracles. Discoidal pores absent. Oral rims similar to those on dorsum; larger size in small numbers on posterior abdomen, smaller size in clusters on marginal areas of posterior abdominal segments, scattered elsewhere. Labium 102–155 μm long. Antenna 263–360 μm long, usually eight- or nine-segmented, third segment completely or

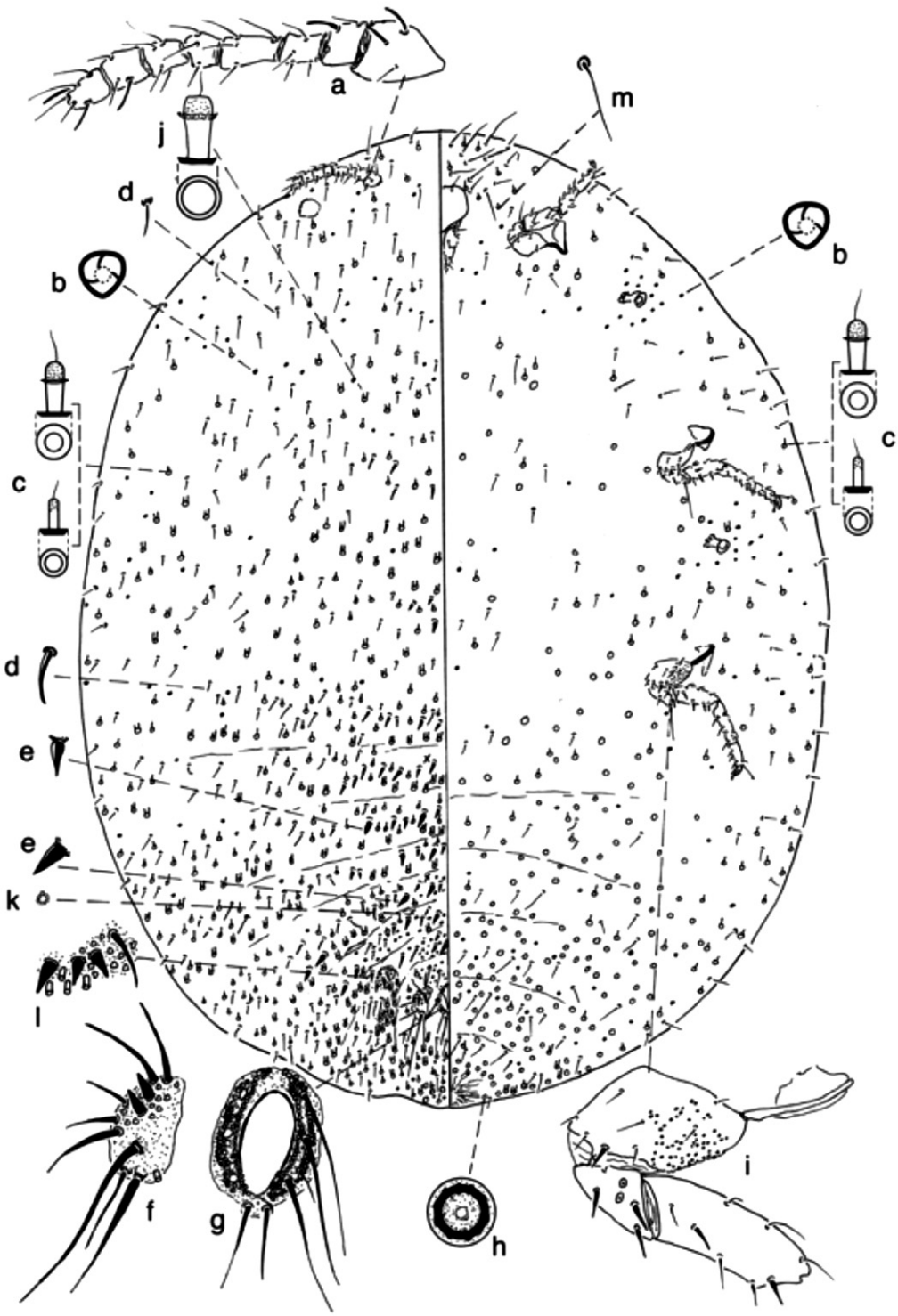

Fig. 1. *Octococcus africanus*. Fully mature adult female. Cape Town, Western Cape, South Africa, ?.i.1898, on *Acacia articulata*, C.K. Brain.

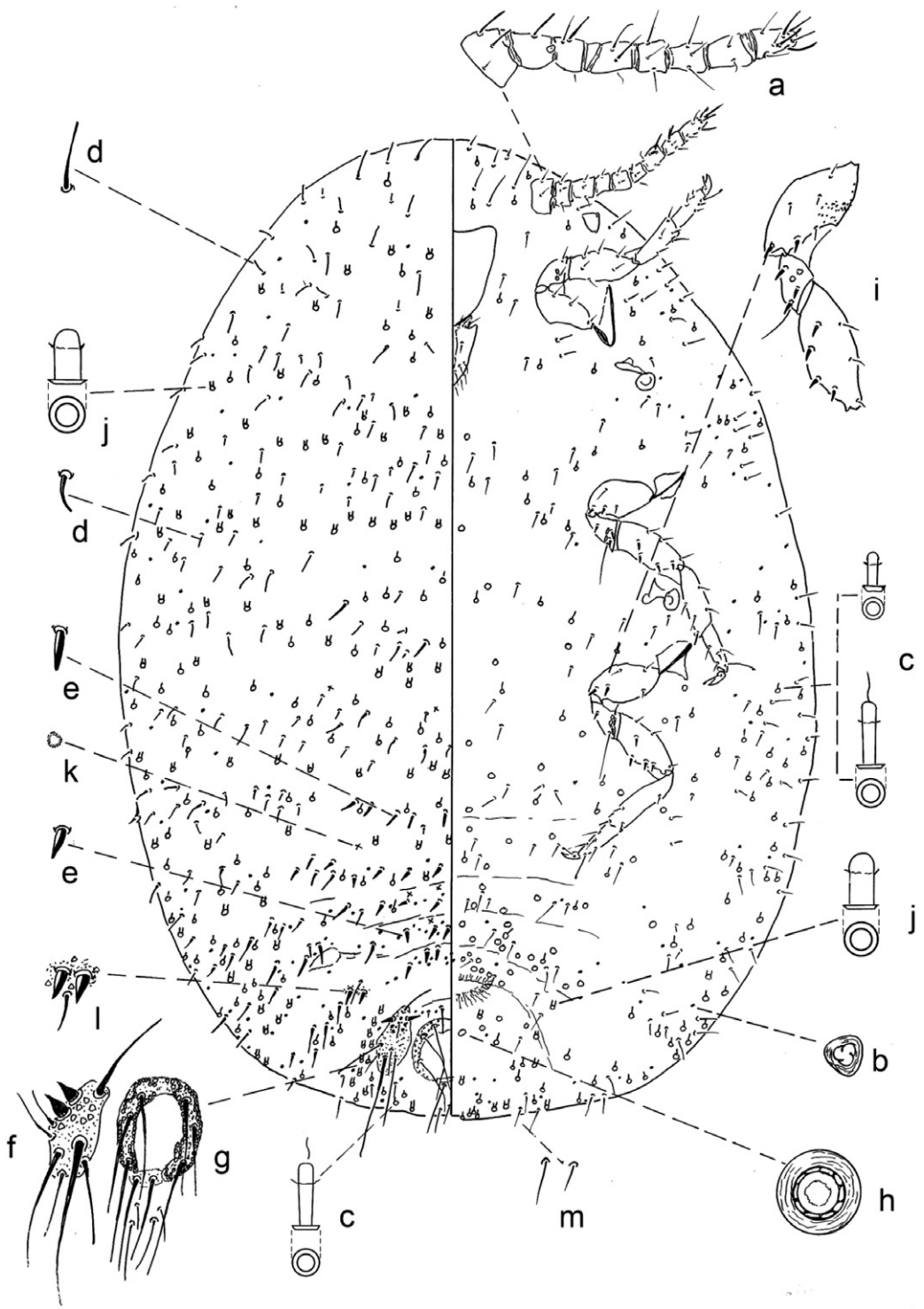

Fig. 2. *Octococcus africanus*. Recently matured adult female. Du Toit's Kloof, Western Cape, South Africa, 9.i.2004, on *Stoebe plumosa* stem, P.J. Gullan & J.H. Giliomee.

Plate 1. *Octococcus africanus*. Two adult females in white waxy sacs and first-instar nymphs on host. Du Toit's Kloof, Western Cape, South Africa, 9.i.2004, on *Stoebe plumosa* stem, P.J. Gullan & J.H. Giliomee. [Photograph by P. Gullan.]

partially divided. Hind coxa with 10–85 small translucent pores, zero to six pores on femur, zero to three pores on hind tibia; femur with five to 12 setae, tibia with six to 16 setae; coxa with one to three setae noticeably larger than other leg setae, trochanter with three such setae, femur with four such setae; tarsal and claw digitules with slightly enlarged apices; apices of tibial digitules on front leg variable, sometimes with one seta with enlarged apex and other seta without acute apex, other times both digitules with enlarged apex. Hind trochanter + femur 150–242 μm long, tibia 100–180 μm, hind tarsus 72–112 μm, tibia/tarsus 1.6–1.8. Without small pores on derm adjacent to hind coxa.

Notes. This species is most similar to *Octococcus barbarae* and *O. minor* by possessing dorsal lanceolate setae on the posterior abdominal segments. *Octococcus barbarae* differs (character states in brackets are those of *O. africanus*) by having dorsal multilocular pores present (absent) and by possessing more than three conical setae in the anal-lobe cerarius (two or three in *O. africanus*). *Octococcus minor* differs by having dorsal multilocular pores present (absent) and by having the large-sized dorsal oral-rim tubular ducts in small numbers, generally restricted to a medial and two lateral longitudinal lines on the abdomen (large-sized dorsal oral-rim tubular ducts numerous, forming transverse rows across the abdominal segments, not restricted to medial and lateral areas).

Octococcus africanus is quite variable; at one point we hypothesised that it included two species, but we were unable to find characters that would consistently separate the species. Two populations (De Doorns and Kamiesberg) usually have small

anterior ostioles and two clubbed tarsal digitules on the front legs, but a few specimens from the same collections lack the anterior ostioles and have one clubbed digitule on each front tarsus. There also is considerable variation in the distribution of the discoidal pores. Some specimens have only one or two such pores that generally are located on the posterior abdominal segments, whereas others have them scattered as far forward as the prothorax.

The host plant of the type series *Tamarix articulata* most likely is a misidentification of *Elytropappus rhinocerotis* which is superficially similar in appearance. Specimens of *O. africanus* have been collected numerous times on plants in *Elytropappus* or in *Stoebe* (both Asteraceae) but only once on '*Tamarix*.'(Tamaricaceae), which is not native in the region where the holotype was collected.

Second-instar female? (Fig. 3)

Slide-mounted characters. Mounted 0.6–0.7 mm long, 0.3 mm wide.

Dorsum. Body with posterior segments normal, not folded on slide-mounted specimens; cerarii near body margin, not displaced medially; anal-lobe area at apex of abdomen, mostly on dorsal surface. With three or four pairs of definite cerarii, additional paired elongate setae present forward to anterior abdominal segments; anal-lobe cerarius unsclerotised, not on prominence, with two conical setae, one auxiliary seta, cluster of two to four basal trilocular pores. Penultimate cerarius in line with anal-lobe cerarius, without basal sclerotisation, not protruding, with two conical setae, no auxiliary setae, and basal cluster of one or two trilocular pores. Suranal setae near apex of abdomen, longest not touching anal ring, with four setae. Trilocular pores scattered over surface of posterior three or four abdominal segments, often with one or two near each eye. Discoidal pores absent. Oral rims of two sizes: larger size barrel-shaped with narrow rim, present over surface from head or prothorax to segment VII, with four ducts on segment IV; smaller ducts narrow and elongate, with large rim, of same distribution pattern as large ducts, but rare on posterior abdominal segments. Unusual sclerotisations absent. Enlarged setae of two shapes, conical and elongate; conical setae nearly as large as those in posterior cerarii, becoming shorter and less enlarged anteriorly, not forming conspicuous medial cerarii, longest conical seta on segment VI 15–18 μm long; elongate setae slightly enlarged but not conical, present from head to segment VII, longest seta on segment VII about 22–32 μm long, with five setae on segment VI between lateral margins of posterior ostioles. Longest anal-ring seta 75–100 μm long, 1.2–1.5 times greater than width of anal ring. Posterior ostioles inconspicuous, with one seta and one or two loosely associated trilocular pores on anterior lip; anterior ostioles small, without associated setae or trilocular pores. Eyes about same size as basal antennal segment, located on dorsum or margin along with antenna.

Venter. Without multilocular pores. Trilocular pores present in submarginal line from metathorax, segments II or III to segment VIII; also with two or three near each spiracle. Discoidal pores absent. Oral rims similar to those on dorsum, larger size in lateral areas of segments IV, V, or VI–VII, medium and smaller size present in marginal areas of head and thorax, in marginal and submarginal areas of abdomen, rare near insertion of legs. Unusual sclerotisations absent. Anal-lobe area at apex of abdomen on venter (not on dorsum as in adult female), with four setae including anal-lobe seta; anal-lobe seta 162–170 μm long. Labium 88 μm long. Antenna 202–218 μm long, seven-segmented. Legs without translucent pores; femur with seven or eight setae, tibia with seven to nine setae, coxa with one seta noticeably larger than other leg setae, trochanter with two or three such setae, femur with three or four such setae; tarsal and claw digitules with slightly enlarged apices, tarsal digitules on front leg with only one clubbed seta; claw without denticle. Hind femur + trochanter 105–120 μm long, tibia 85–95 μm long, hind tarsus 75–80 μm, tibia/tarsus 1.1–1.3. Without pores on derm near hind coxa.

Notes. This description is based on four specimens from one locality. We also have studied seven second-instar nymphs that are in the process of moulting but remain inside the cuticle of the first-instar nymph. Although it is difficult to make out many details of these specimens, they all possess dorsal oral-rim tubular ducts of both sizes in approximately the same arrangement as discussed above.

First-instar nymph (Fig. 4, Plate 1)

Field characters. Body oval, dark grey to black, without wax covering or with wax covering on posterior abdominal segements. With one pair of white caudal filaments. Wax tube produced by

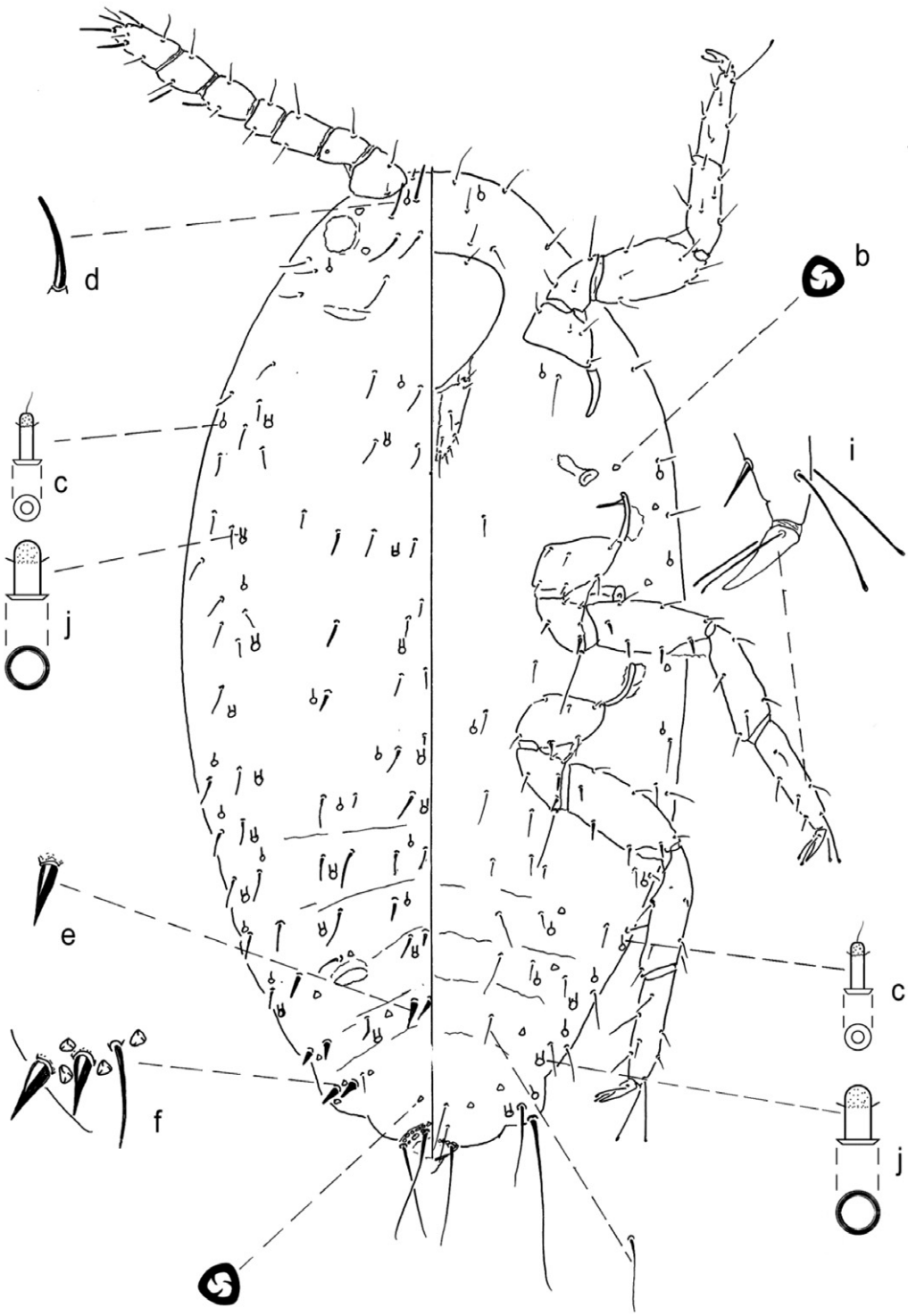

Fig. 3. *Octococcus africanus*. Second-instar female. Du Toit's Kloof, Western Cape, South Africa, 9.i.2004, on *Stoebe plumosa* stem, P.J. Gullan & J.H. Giliomee.

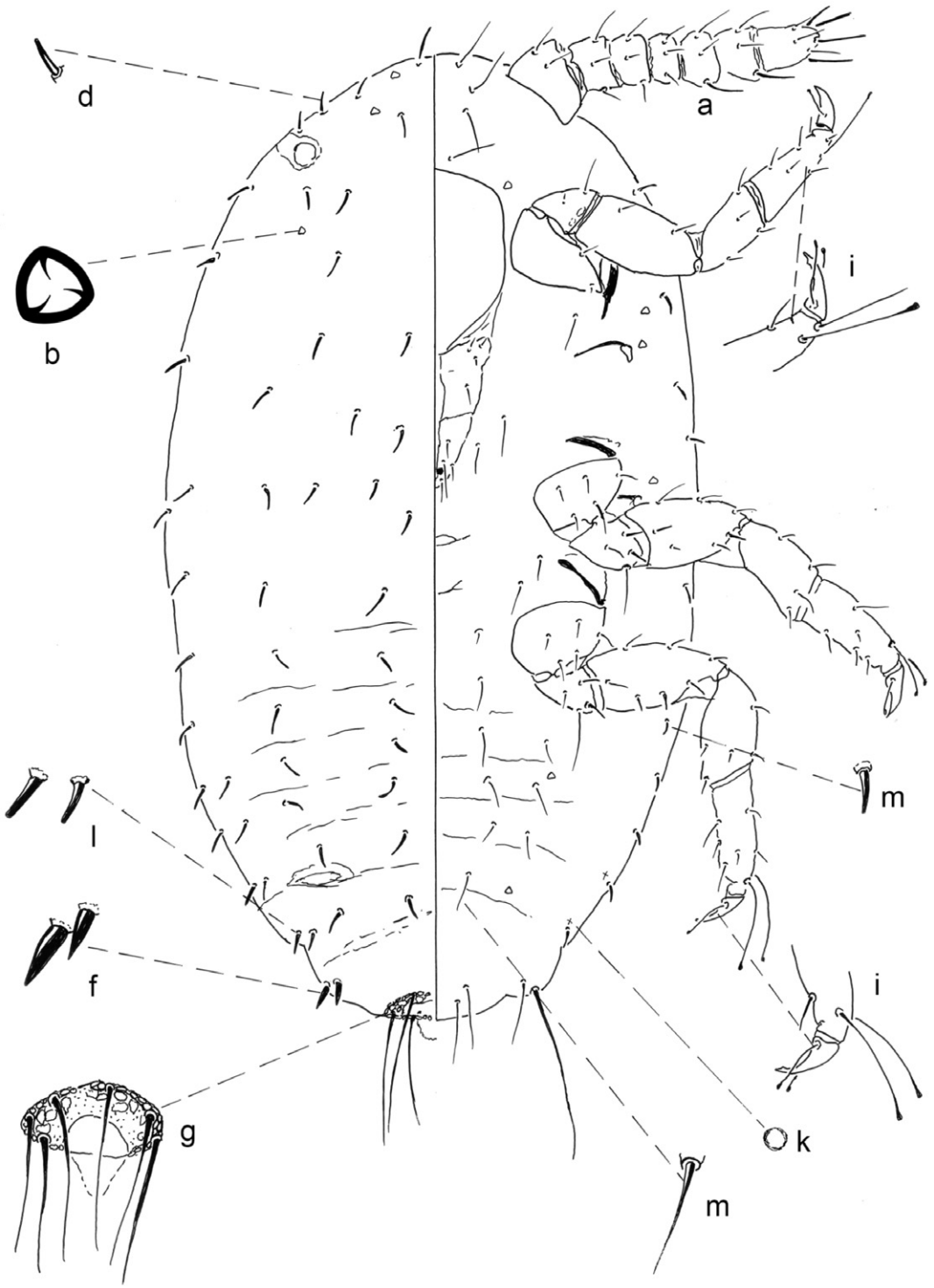

Fig. 4. *Octococcus africanus*. First-instar nymph. 37 km ENE Ceres, Klondyke Cherry Farm, Western Cape, South Africa, 28.xii.2004, on *Elytropappus rhinocerotis*, P.J. Gullan.

anal ring white, longer than lateral wax filaments.

Slide-mounted characters. Mounted 0.4–0.6 mm long, 0.2–0.4 mm wide.

Dorsum. Body with posterior segments normal, not folded; cerarii near body margin, not displaced medially; anal-lobe area at apex of abdomen. With two pairs of definite cerarii, additional six pairs of elongate setae present forward to anterior abdominal segment; anal-lobe cerarius unsclerotised, not on prominence, with two conical setae, one seta often shorter and thinner, no auxiliary seta, usually with one basal trilocular pore, sometimes absent. Penultimate cerarius in line with anal-lobe cerarius, without basal sclerotisation, not protruding, with two conical setae, one seta often shorter and thinner, no auxiliary setae, and with or without one basal trilocular pore. Suranal setae near apex of abdomen, longest close to, but not touching anal ring, with four setae. Trilocular pores usually present in submedial area of segment VIII, submedial area of prothorax, and laterally on head, sometimes present submedially on segment I, metathorax, and mesothorax, laterally on mesothorax, prothorax, and head. Discoidal pores absent. Oral rims absent. Unusual sclerotisations absent. Enlarged setae of one shape, more elongate and thinner than conical setae in cerarii, becoming shorter and less enlarged anteriorly, not forming conspicuous medial cerarii, longest conical seta on segment VI 9–16 μm long; with enlarged setae only, without elongate setae. With four setae on segment VI between lateral margins of posterior ostioles. Longest anal-ring seta 52–65 μm long, 1.1–1.5 times greater than width of anal ring. Posterior ostioles inconspicuous, with one seta and no trilocular pores on anterior lip; anterior ostioles absent. Eyes smaller than basal antennal segment, located on body margin.

Venter. Without multilocular pores. Trilocular pores usually present submarginally on segments VII and III, near anterior end of clypeus, and near anterior and posterior spiracles, sometimes also present submarginally on segments II, IV, V, and VIII; with two to four near each spiracle. Discoidal pores absent or present in submarginal line near lateral setae. Unusual sclerotisations absent. Anal-lobe area at apex of abdomen on venter (not on dorsum as in adult female), with two setae including anal-lobe seta; anal-lobe seta 88–120 μm long. Labium 60–76 μm long. Antenna 142–170 μm long, eight-segmented. Legs without translucent pores, femur with seven to nine setae, tibia with seven to nine setae; coxa with one seta noticeably more enlarged than other setae, trochanter with three such setae, femur with three or four such setae; tarsal and claw digitules with slightly enlarged apices, tarsal digitules on front leg with only one clubbed seta; claw without denticle. Hind femur + trochanter 75–98 μm long, tibia 50–68 μm long, hind tarsus 58–70 μm, tibia/tarsus 0.8–1.0. Without pores on derm near hind coxa.

Notes. This description is based on 90 specimens from four localities. It is most similar to *O. warniae* by having two pairs of cerarii, but differs by having a nearly complete marginal line of trilocular pores, whereas *O. africanus* either lacks marginal trilocular pores or has them restricted to segments VII and VIII in the cerarii.

Octococcus barbarae Miller & Giliomee, **sp. n.**, Fig. 5

Etymology. The specific epithet is named in honour of Barbara D. Denno in recognition of her hundreds of hours of volunteer work on ScaleNet, including management of the web site, troubleshooting, and data entry. She also helps the first author with various areas of information technology, assists with fieldwork, collection management, and general encouragement.

Type material. Holotype adult female is mounted alone and is deposited in SANC. Left label '4303: 1/ S. Afr: Cape Pr./ Caledon: ? 23.x.1969/on: Eroeda/ latifolia/ coll.: P. Insley' right label 'Octococcus/ barbarae/ Miller &/ Giliomee HOLOTYPE.' There are no other specimens. The correct name of the host plant is *Oedera imbricata* and the province is the Western Cape. This species is known only from the holotype.

Field characters. No information is available

Adult female (Fig. 5)

Slide-mounted characters. Mounted 1.8 mm long, 1.2 mm wide.

Dorsum. Body not fully distended but posterior segments partially folded on slide-mounted specimens so that anal ring and anal lobes located forward from posterior end of body; cerarii near body margin, not displaced medially; anal-lobe area placed on dorsal surface rather than normal position on venter. With two pairs of cerarii; anal-lobe cerarius sclerotised, on prominence, with nine conical setae, without elongate setae, cluster of 12 or 13 basal trilocular pores. Penultimate cerarius in line with anal-lobe cerarius, unsclerotised, definition of cerarius not clear, with seven conical setae

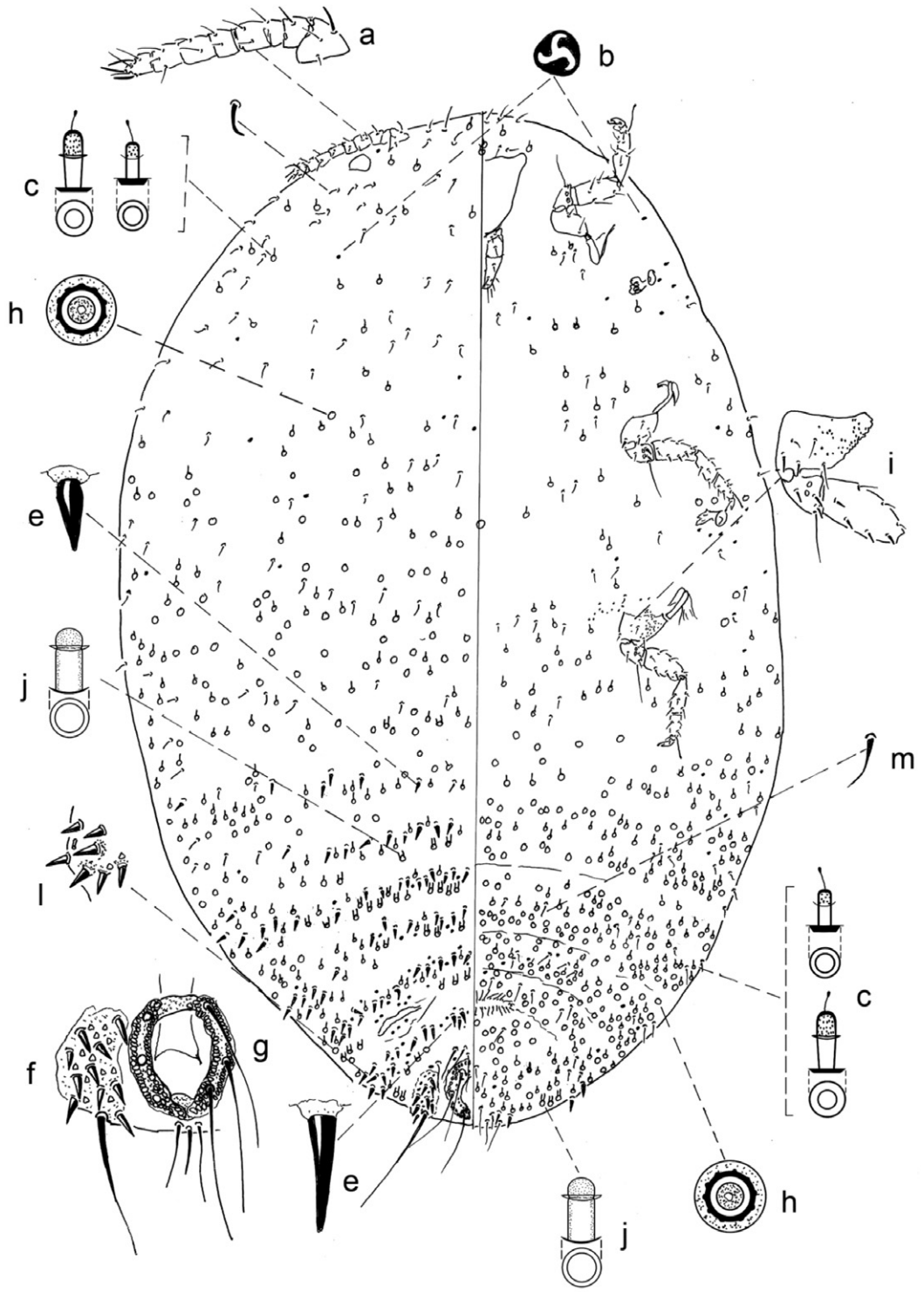

Fig. 5. *Octococcus barbarae*. Adult female. Caledon, Western Cape, South Africa, 23.x.1969, on *Oedera imbricata*, P. Insley.

about same size as anal-lobe conical setae, without auxiliary setae, and basal cluster of two trilocular pores. Without additional cerarii. Anal-lobe area sclerotised, contiguous with anal-lobe cerarius, with four setae, longest about 155 μm long. Suranal setae near apex of abdomen, none touching sclerotisation of anal ring, with six setae. Multilocular pores present in medial areas of mesothorax to segment III, present laterally on segments IV–VII. Discoidal pores absent. Trilocular pores uncommon, scattered over surface, most abundant in cerarii and near base of dorsomedial conical setae. Oral rims usually with weakly developed rim, of two or three intergrading sizes: larger sizes distinct, with thin, heavily sclerotised rim, most abundant posteromedially on segments III–VI, also laterally on segments VII and VIII, absent elsewhere, with 20 ducts present on segment IV; smaller size with broad rim and narrow tube, abundant over surface except absent from medial areas of segments VII and VIII. Lanceolate setae present in medial areas from segments II–VII, about same size as cerarian setae, distributed in rows, not forming medial cerarii, longest conical seta on segment VI 28 μm long. Body setae of variable size, all setae on posterior abdominal segments enlarged, with 21 setae on segment VI between lateral margins of posterior ostioles. Longest anal-ring seta 125 μm long, 1.2 times longer than width of anal ring. Posterior ostioles with two or four setae on anterior lip and four or six trilocular pores, with three trilocular pores on posterior lip; anterior ostioles absent. Eye diameter about same size as length of second antennal segment, located on dorsum along with antenna.

Venter. Vulva in holotype located in normal position for mealybugs. Multilocular pores abundant on abdomen, rare on thorax, absent from head and anterior thorax, submarginal pores abundant. Trilocular pores uncommon, scattered over surface, most abundant in lateral areas of thorax near spiracles. Discoidal pores absent. Oral rims similar to those on dorsum, larger size in small numbers on posterior abdomen, smaller sizes in clusters on marginal areas of posterior abdominal segments, scattered elsewhere. Labium 100 μm long. Antenna 208 μm long, seven- or eight-segmented, basal segment and second segment each with one or two enlarged setae. Hind coxa with 60 and 80 small translucent pores, with similar pores on derm adjacent to hind coxa, without pores on hind femur or tibia; femur with nine setae, tibia with seven and nine setae; coxa with two setae noticeably larger than other leg setae, trochanter with two such setae, femur with four such setae; tarsal and claw digitules with slightly enlarged apices; one of tibial digitules on front leg without enlarged apex. Hind trochanter + femur 115 and 122 μm, tibia 78 and 70 μm long, hind tarsus 52 and 55 μm, tibia/tarsus 1.3 and 1.5. With small pores on derm adjacent to hind coxa.

Notes. This species is most similar to *Octococcus minor* by having dorsal lanceolate setae on the posterior abdominal segments, small pores adjacent to the hind coxa, and dorsal multilocular pores; it differs (character states of *O. minor* are given in brackets) by having nine enlarged setae in the anal-lobe cerarii (two or three), seven enlarged setae in the penultimate cerarii (two or three), and more than 10 large-sized oral-rim tubular ducts on segment IV (less than nine).

Octococcus gullanae Miller & Giliomee **sp. n.**, Fig. 6

Etymology. The specific epithet is named in honour of Penny Gullan in recognition of her many significant contributions to scale insect systematics and for making several collections of *Octococcus* in South Africa, mounting them on slides, sending them to us for this revision, and providing a thoughtful and careful review of the manuscript.

Type material. Holotype adult female mounted singly on a slide and deposited in SANC. Left label 'H.C. No. 664/ 1/ S. A.: Cape Prov. [now Northern Cape] Nieuwoudtville:/ 11.vii.1961/ex.: Lampranthus/sp./ coll.: J.H. Giliomee' right label 'Octococcus/ gullanae Miller & /Giliomee/ HOLOTYPE.' In addition there is one paratype adult female from the same series (USNM) and one paratype adult female from Oudtshoorn. [Western Cape Province] on 'mesem' [*Mesembryanthemum*], collector unknown, ?.iii.1979, 1/1 ad. fem. (SANC 5702-1). *Lampranthus* is a mesemb and belongs to the ice-plant family, Aizocaeae.

Field characters. No information; however, based on the morphology of the slide-mounted adult female we suspect that there are four or five lateral wax filaments.

Adult female (Fig. 6)

Slide-mounted characters. Numerical values are given for the holotype first and the paratypes in brackets. Mounted 3.1 mm long, 2.4 mm wide (1.4 and 3.5 mm long, 0.8 and 2.7 mm wide).

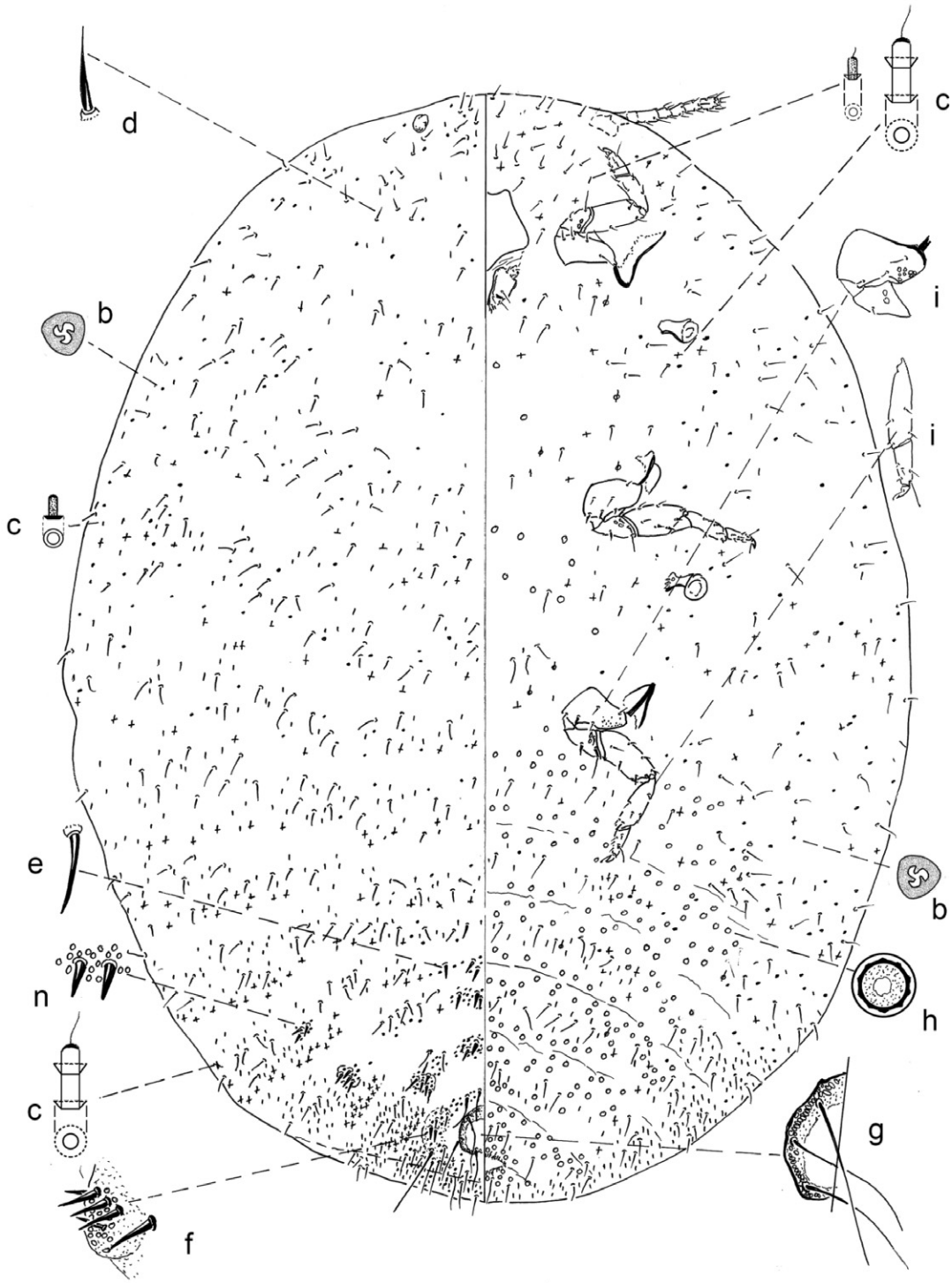

Fig. 6. *Octococcus gullanae*. Adult female. Nieuwoudtville, Northern Cape, South Africa, 11.vii.1961, on *Lampranthus* sp., J.H. Giliomee.

Dorsum. Body greatly enlarged in mature specimens; posterior segments folded only on older females; cerarii not near body margin on older females, displaced medially, present near body margin on young female; anal-lobe area placed on dorsal surface on older females, in normal position on young female. With four or five pairs of cerarii; anal-lobe cerarius sclerotised, on prominence, with four and six conical setae (three or four), zero and two auxiliary setae (three to five), cluster of seven (11–12) trilocular pores. Penultimate cerarius not forming line with other cerarii, displaced medially, weakly sclerotised, on small prominence, with three conical setae (three or four), two auxiliary setae (one or two), and cluster of 12 (five to 14) trilocular pores. Third cerarius weakly sclerotised, on small prominence, with three or four conical setae (three or four), without auxiliary setae (zero to two), with cluster of 11 (five to 10) trilocular pores. Fourth cerarius weakly sclerotised, on small prominence, with two or three conical setae (two), without auxiliary setae (zero or one), with cluster of four (two to four) trilocular pores. Fifth cerarius when present represented by one conical seta (one), one or two more elongate setae, no basal sclerotisation or trilocular pores. Anal-lobe area sclerotised, contiguous with anal-lobe cerarius, with four or five (four to six) long setae. Discoidal pores absent. Trilocular pores scattered over surface, most abundant in cerarii and near base of dorsomedial conical setae. Large-sized oral rims with narrow rim and narrow tube (broad tube normally present on other species, absent on this species). Oral rims usually with weakly developed rim, of three intergrading sizes: larger size most abundant posterolaterally on posterior abdominal segments, scattered elsewhere, uncommon on head, with 32 (22 and 36) ducts on segment IV; smaller two sizes abundant over surface. Lanceolate setae present in medial areas of segments IV–VIII, about same size as cerarian setae, forming medial cerarii with basal trilocular pores and slight sclerotisation. Body setae of one variable size, longest setae near posterior end of abdomen, longest seta on segment VII about 60 μm long (38 and 60), with 18 (13 and 17) setae on segment VI between lateral margins of posterior ostioles. Longest anal-ring seta 152 μm long (105 and 152), 1.3 (0.9 and 1.2) times longer than width of anal ring. Posterior ostioles when present with zero to three loosely associated trilocular pores on anterior lip; anterior ostioles absent. Eye diameter about same size as length of second segment of antenna, located on dorsum along with antenna.

Venter. Vulva located near posterior apex of abdomen on mature specimens. Multilocular pores present from prothorax to posterior apex of abdomen, submarginal pores absent. Trilocular pores uncommon, present in lateral areas of anterior abdominal segments and thorax. Discoidal pores absent. Oral rims similar to those on dorsum, larger size in small numbers on abdomen and thorax, smaller size in clusters on marginal areas of posterior abdominal segments, scattered elsewhere. Suranal setae near apex of abdomen, with six setae (five to seven). Labium 135 μm long (150). Antenna 370 μm long (310–345), eight-segmented (seven or eight), third segment completely or partially divided. Hind coxa with 23 and 74 translucent pores (21–37), femur with nine setae (eight and nine), some slightly enlarged; tarsal and claw digitules with slightly enlarged apices. Hind trochanter + femur 270 μm long (215); hind tibia 175 μm long (162 and 168); hind tarsus 92 and 95 μm (88 and 90); tibia/tarsus 1.9 (1.8 and 1.9). Leg setae on ventral surface of coxa, trochanter, femur, and tibia larger than setae on dorsum of each segment and on tarsus.Without small pores on derm adjacent to hind coxa.

Notes. This species is most similar to *Octococcus africanus* (character states of *O. africanus* given in brackets) but differs by having four or five pairs of cerarii (two), each cerarius with more than two conical setae (two), cerarii set away from body margin (near body margin), rims of oral-rim tubular ducts inconspicuous (conspicuous)

Octococcus minor De Lotto, Figs 7–8

Octococcus minor De Lotto, 1969: 16 (original designation); Ben-Dov, 1994: 258; Millar, 2002: 201.

Octococcus africanus; Afifi, 1968: 151 (misidentification); Hardy *et al*. 2008: 57 (misidentification of adult male in character matrix)

Type material. We have examined the holotype and three paratypes with the following data: left label 'H. C. No. 839/9 /S. A. Cape Pr./ Middelburg:/ 7.v.1964/ ex. Nestlera/ humilis/ coll. C.H. Buitendag' right label 'Octococcus/ minor/ De Lotto/ HOLOTYPE.' The holotype and nine paratypes are in SANC and one paratype is in each of the USNM and BMNH. The current name of the host plant is *Rosenia humilis* (Asteraceae).

Additional material examined, SOUTH AFRICA:

Free State: Bloemfontein, 13.vi.1951 and 20.vii. 1951, on *Chrysocoma tenuifolia*, H. Gleimius, 2/2 ad. fem. (SANC 657-1 & 658-1); Bloemfontein, 8.ix.1966, on *Chrysocoma* sp., J.F. Louw 3/3 ad. fem. (SANC 2542 3–5). Mpumalanga Province: Middelburg, ?.viii.1946, on *Chrysocoma tenuifolia*, A. de Vries 1/1 ad. fem. (SANC 659-1); Northern Cape Province: Colesberg Bridge, on *Nolletia* sp., 26.ix.1952, O.W. Richards, 3/14 ad. fem., /7 first-instar embryos, /2 ad. males (BMNH); Kamieskroon, 16.ix.1967, on *Chrysocoma* sp., H.D. Brown 1/1 ad. fem. (SANC 2910-1); Kamieskroon, Cosy Mt., 800 m. elevation, 30°10′S 17°56′E, 4.x.2005, on ?*Chrysocoma ciliata* stems, P.J. Gullan, 2/2 ad. fem. (SANC); Petrusville, 6.viii.1975, on *Chrysocoma tenuifolia*, J.D. Mohr. 1/1 ad. fem. (SANC 5203-1); Postmasburg, 24.vii.1963, on ?, D.J. Claassen, 1/1 ad. fem. (SANC 719-1); Sutherland, 13.ix.1966, on *Pteronia incana*, H.D. Brown, 1/1 ad. fem. (SANC 2291-1). Western Cape Province: Swellendam, on *Stoebe* sp., ?.ix.1923, P. O. Drew, 1/1 ad. fem. (SANC 649-1).

Field characters. No information.

Adult female (Fig. 7)

Slide-mounted characters. Mounted 1.0–3.4 mm long, 0.6–2.4 mm wide.

Dorsum. Body with smaller specimens with posterior segments slightly folded, larger specimens with dorsal segments folded over, anal ring and anal lobes near posterior end of body on most specimens, larger specimens with anal ring located more anteriorly; one specimen with anal-lobe seta apical, others with anal-lobe seta on dorsum; cerarii slightly displaced medially; anal-lobe area placed on dorsal surface rather than normal position on venter. With two pairs of cerarii; anal-lobe cerarius sclerotised, on prominence, with two rarely three conical setae, three to five more elongate setae, cluster of five to 10 basal trilocular pores. Penultimate cerarius in line with anal-lobe cerarius, sclerotised, with two conical setae about same size as anal-lobe conical setae, without auxiliary setae, and basal cluster of zero to two trilocular pores. Without additional cerarii. Anal-lobe area sclerotised, contiguous with anal-lobe cerarius, with three to six setae, longest about 88–180 μm long. Suranal setae near apex of abdomen, with two to seven setae, none attached to anal ring. Multilocular pores present laterally from mesothorax to segments V or VI, medially from mesothorax to segments II, III, or IV, some specimens with multilocular pores more abundant from mesothorax to segment VII. Discoidal pores uncommon, normally with one or two on any of segments IV–VII. Trilocular pores uncommon becoming less abundant anteriorly, most abundant in cerarii and near base of dorsomedial conical setae. Oral rims usually with weakly developed rim, of three intergrading sizes: larger size distinct, with thin, heavily sclerotised rim, arranged in lateral, mediolateral, and medial longitudinal lines, present laterally on any of segments V, VI, or VII, mediolaterally on any or all of segments III to VII, medially on segments I or II–VI or VII, with two to five ducts on segment IV; medium- and small-sized ducts with broad rim and thin tube, medium-sized ducts absent on posterior segments, scattered over remainder of surface; small-sized ducts most abundant laterally, scattered over surface. Lanceolate setae present in medial areas of segments III or IV–VI or VII, one specimen with relatively elongate setae on segment VII, about same size as cerarian setae, distributed in rows, not forming medial cerarii, longest lanceolate seta on segment VI 18–27 μm long. Body setae of one variable size, longest setae near posterior end of abdomen, longest seta on segment VII 40–48 μm long, with 14–21 setae on segment VI between lateral margins of posterior ostioles. Longest anal-ring seta 98–155 μm long, 1.1–1.7 times longer than width of anal ring. Posterior ostioles small and inconspicuous, with zero to two loosely associated trilocular pores on anterior lip; anterior ostioles absent. Eye diameter conspicuously longer than length of second antennal segment, about same size as basal antennal segment, usually located on venter or body margin.

Venter. Vulva located anterior of posterior apex of abdomen in newly formed specimens. Multilocular pores present from prothorax, mesothorax, or metathorax to posterior apex of abdomen, submarginal pores abundant. Trilocular pores uncommon, scattered over surface, most abundant in lateral areas of anterior abdominal segments, thorax and near spiracles. Discoidal pores rare, usually present near insertion of legs. Oral rims similar to those on dorsum; larger size in small numbers on posterior abdomen, smaller size in clusters on marginal areas of posterior abdominal segments, scattered elsewhere. Labium 92–125 μm long. Antenna 146–218 μm long, usually eight-segmented, rarely seven. Hind coxa with five to 33 small translucent pores, without pores on femur,

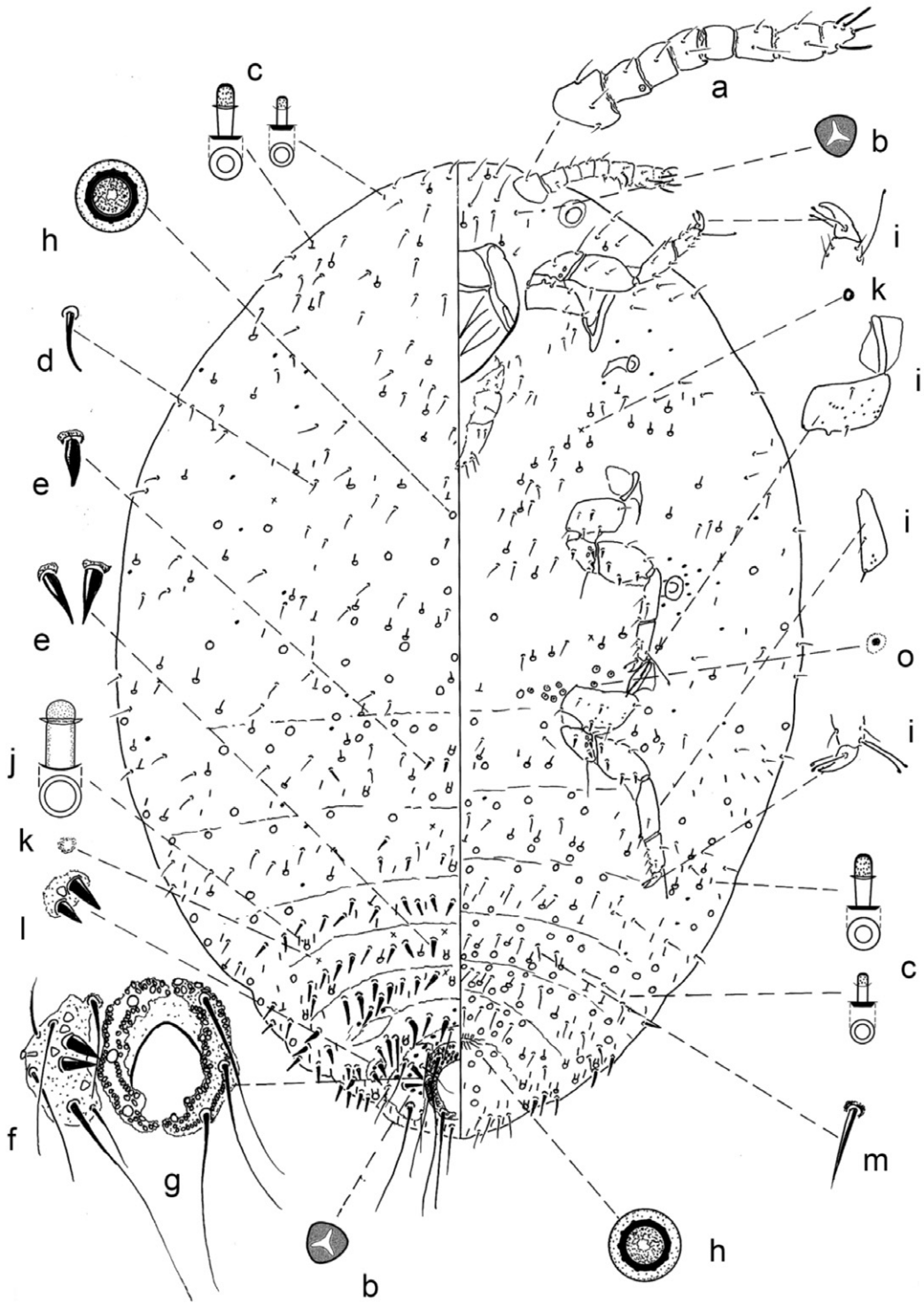

Fig. 7. *Octococcus minor.* Adult female. Bloemfontein, Free State, South Africa, 13.vi.1951, on *Chrysocoma tenuifolia*, H. Gleimius,

zero to seven pores on hind tibia; femur with six to nine setae, tibia with four to seven setae; coxa with two to four setae noticeably larger than other leg setae, trochanter with two or three such setae, femur with four such setae; tarsal and claw digitules with slightly enlarged apices; one of tibial digitules on front leg without enlarged apex. Hind trochanter + femur 98–200 μm, tibia 55–91 μm long, hind tarsus 43–65 μm, tibia/tarsus 1.2–1.5. With small pores on derm adjacent to hind coxa.

Notes. This species is most similar to *Octococcus barbarae* by having dorsal lanceolate setae on the posterior abdominal segments, small pores adjacent to the hind coxa, and dorsal multilocular pores; it differs (character states of *O. barbarae* are given in brackets) by having two or three enlarged setae in the anal-lobe cerarii (nine), two or three enlarged setae in the penultimate cerarii (seven), and less than nine large-sized oral-rim tubular ducts on segment IV (more than 10).

First-instar nymph (Fig. 8)

Slide-mounted characters. Mounted 0.4–0.5 mm long, 0.2–0.3 mm wide.

Dorsum. Body with posterior segments normal, not folded; cerarii near body margin, not displaced medially; anal-lobe area at apex of abdomen, mostly on ventral surface. With four pairs of definite cerarii, additional three or four pairs of elongate setae present forward to anterior abdominal segment I or II; anal-lobe cerarius unsclerotised, usually on slight prominence, with two conical setae, approximately equal in size and shape, without auxiliary seta, with one tubular trilocular pore between conical setae. Penultimate cerarius in line with anal-lobe cerarius, without basal sclerotisation, not protruding, with two conical setae approximately equal in size and shape, no auxiliary setae, and with one tubular trilocular pore between conical setae. Cerarii 3 and 4 similar to anal-lobe cerarius but conical setae slightly smaller and tubular trilocular pore often located laterad of conical setae. Trilocular pores of two sizes; larger size tubular, noticeably longer than wide, present marginally and submarginally on abdomen and thorax; smaller size about equal in length and width, present on head. Discoidal pores absent. Oral rims absent. Unusual sclerotisations absent. Enlarged setae only setal type present, of one shape, more elongate and thinner than conical setae in cerarii, becoming shorter and less enlarged anteriorly, not forming conspicuous medial cerarii, longest conical seta on segment VI 12–18 μm long; with four setae on segment VI between lateral margins of posterior ostioles. Longest anal-ring seta 75–95 μm long, 1.7–2.3 times greater than width of anal ring. Posterior ostioles inconspicuous, with one seta and no trilocular pores on anterior lip; anterior ostioles absent. Eyes smaller than basal antennal segment, located on body margin.

Venter. Without multilocular pores. Trilocular pores of small size only, present near base of antenna and near spiracles. Discoidal pores absent. Unusual sclerotisations absent. Anal-lobe area at apex of abdomen on venter (not on dorsum as in adult female), with two setae including anal-lobe seta; anal-lobe seta 82–102 μm long. Suranal setae near apex of abdomen, longest close to, but not touching anal ring, with four setae. Labium 62–75 μm long. Antenna 142–155 μm long, eight-segmented. Legs without translucent pores, femur with seven to eight setae, tibia with seven setae; coxa with two to four setae noticeably more enlarged than other setae, trochanter with one to three such setae, femur with one to four such setae; tarsal and claw digitules with slightly enlarged apices, tarsal digitules on front leg with only one clubbed seta; claw without denticle. Hind femur + trochanter 80–95 μm long, tibia 45–55 μm long, hind tarsus 55–71 μm, tibia/tarsus 0.8–0.9. Without pores on derm near hind coxa.

Notes. The description and illustration are based on seven poorly mounted embryos from one locality. It is most similar to the first-instar nymph of *O. warniae* by having a marginal line of trilocular pores on the dorsum, but differs by having four pairs of cerarii with conical or lanceolate setae and tubular trilocular pores, whereas *O. warniae* has only two pairs of cerarii with conical setae and sessile trilocular pores.

Adult male

The adult male of this species was described as *Octococcus africanus* in great detail by Afifi (1968) based on 10 specimens collected at the Colesberg Bridge locality given below.

Notes. This species is most similar to *O. barbarae*. For a comparison see the notes section of that species. The first instar of this species differs from the first instars of the two other known species by having four pairs of cerarii each with two conical setae and two sizes of trilocular pores, those in the

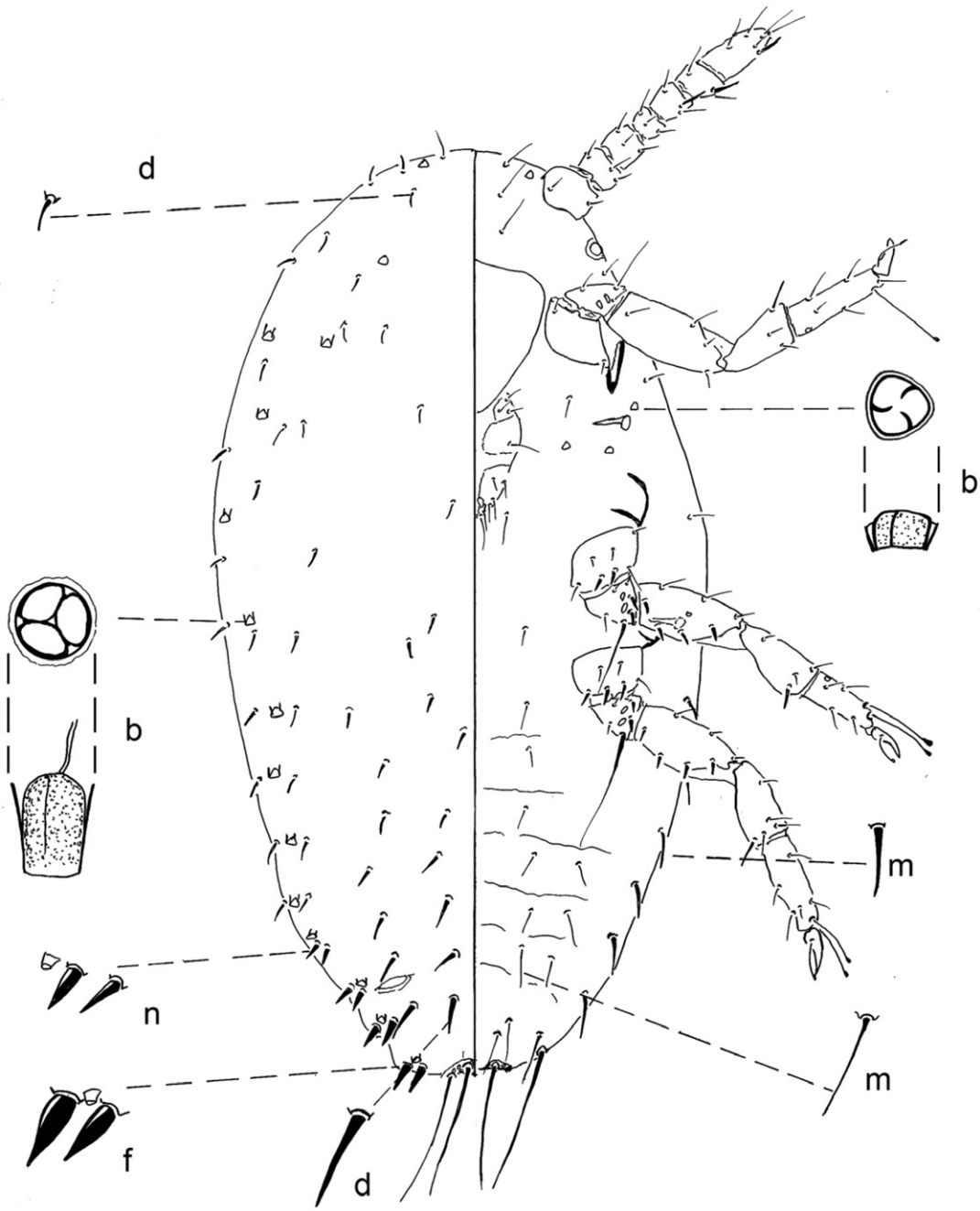

Fig. 8. *Octococcus minor*. First-instar embryo. Colesberg Bridge, Northern Cape, South Africa, 26.ix.1952, on *Nolletia* sp., O.W. Richards.

dorsomarginal areas are noticeably tubular. The first instars *O. africanus* and *O. warniae* have only two pairs of cerarii with conical setae and one size of trilocular pore that is not conspicuously tubular.

Octococcus pentziae Hall, Fig. 9

Octococcus pentziae Hall, 1939: 93 (original designation); Williams, 1958: 6; Ben-Dov, 1994: 249; Morrison & Morrison, 1966: 137; Giliomee, 1966: 417; Millar, 2002: 201.

Type material. We have examined seven paratype adult females deposited in SANC. We have not examined the holotype that is deposited in BMNH (Giliomee 1966), but we have examined 11 paratype females on four slides from the BMNH. We also received an e-mail from Paul Brown indicating that there are many paratypes, other slides, and dry material of this species in BMNH.

Material examined, SOUTH AFRICA: Eastern Cape province: Fort Beaufort, ?-v-1947, on *Pentzia incana*, J.S. Taylor 2/5 ad. fem. (CIE 1343); Great Fish River Reserve, 33°07′S, 26°40′E, on *Pentzia incana*, 23&25.x.2005, P.J.Gullan, 5/11 ad. fem. (SANC); Great Fish River Reserve, 33°07′S 26°40′E, on *Ursinia anthemoides*, 25.xi.2005, P.J.Gullan, 4/8 ad. fem. (SANC); Somerset East, 13.iii.1975, on *Pentzia incana*, J.H. Mohr, 4/4 ad. fem. (SANC 5126 1–4); Somerset East, 2.iii.1960, on *Pentzia incana*, A.H. de Vries, 1/1 ad. fem. (CIE 5521.17085; BMNH 1961/1). Free State: Edenville, 7.i.1970, on *Pentzia globosa*, P. Insley, 1/1 ad. SANC. Left label engraved 'Octococcus/ pentziae/ Hall/ Pentzia sp./ Grootfontein/ Middelburg/ Cape Nov 1935/ 556' right label '556: 2/ PARATYPE/ W.J. Hall/ 4 22.2.39.' Additional data from the original description includes Grootfontein School of Agriculture; the collector is unknown, fem. (SANC 4372-1); Fauresmith, ?.ii.1931, on *Pentzia globosa*, H.K. Munro, 1/1 ad. fem. (SANC 725-1). Mpumalanga province: Grootfontein, 12.iii.1968, on *Pentzia incana*, M.W. Pretorius, 1/1 ad. fem. (BMNH 1958-229); Middelburg, 19.iv.1963, *Chrysocoma tenuifolia*, P. Hugo, 9/9 ad. fem. (SANC 1308 1, 3–10); Middelburg, 27.ii.1975, on *Pentzia globosa*, J.D. Mohr, 9/9 ad. fem. (SANC 5117 1–2 & 5185 1–7); Middelburg, 18.vi.1976, on *Pentzia incana*, E.V. Cloete, 1/1 ad. fem. (SANC 5189-1). Northern Cape Province: Hanover, 29.viii.1954, on *Pentzia* sp., J. Nel, 2/2 ad. fem. (SANC 648-2); Petrusville, 21.iii.1975, on *Pentzia virgata*, J.D. Mohr, 3/3 ad. fem. (SANC 5128 1–3); Victoria West, 27.iii.1975, on *Pentzia spinescens*, J.D. Mohr (SANC 5130 1–2).

Field characters. From Hall (1939) 'Adult female enclosed in a closely felted sac which is white or more often dirty white on account of extraneous matter which has become incorporated. The sac is broadly ovoid and convex, almost globular, with a small orifice towards one extremity. Dead adult females smoky black or very dark purple, shrivelled and very small-rarely exceeding 1 mm. in length. The dermis appears to be devoid of secretionary covering and no lateral or caudal filaments apparent. The adult female when mounted for microscopical examination is oval in outline, small and often shrivelled and rarely exceeds 1.5 mm in length and 1.0 mm. in breadth.'

Adult female (Fig. 9)

Slide-mounted characters. Mounted 0.9–1.5 mm long, 0.5–1.1 mm wide.

Dorsum. Body with posterior segments slightly folded on larger slide-mounted specimens, newly mature specimens without folding; cerarii near body margin, not displaced medially; except in very small specimens, anal-lobe area placed on dorsal surface rather than normal position on venter. With two pairs of cerarii; anal-lobe cerarius sclerotised, often on prominence, with two, rarely three, conical setae, two to four auxiliary setae, cluster of two to nine basal trilocular pores. Penultimate cerarius in line with anal-lobe cerarius, with patchy basal sclerotisation, not protruding, with two, or rarely one, conical setae, one to three auxiliary setae, and basal cluster of one to four trilocular pores. Anal-lobe area normally on dorsum but at apex of venter on small specimens, sclerotised, contiguous with anal-lobe cerarius, with three to six auxiliary setae, longest 150–210 μm long. Suranal setae near apex of abdomen, longest sometimes touching anal ring, with three to five setae. Discoidal pores uncommon, when present located near anterior margin of posterior segments. Trilocular pores scattered over surface, not concentrated near base of dorsomedial enlarged setae. Oral rims of two or three sizes: larger size distinct, with thin, heavily sclerotised rim, barrel-shaped, present laterally from thorax or anterior abdominal segments to segments VI or VII, present in medial area in single longitudinal line from head, prothorax, or mesothorax to segments VI or VII, with two to six ducts on segment IV; medium and small ducts narrow and elongate, with large rim, scattered over surface from head to segment VII, abundant on head. Unusual sclerotisations some-

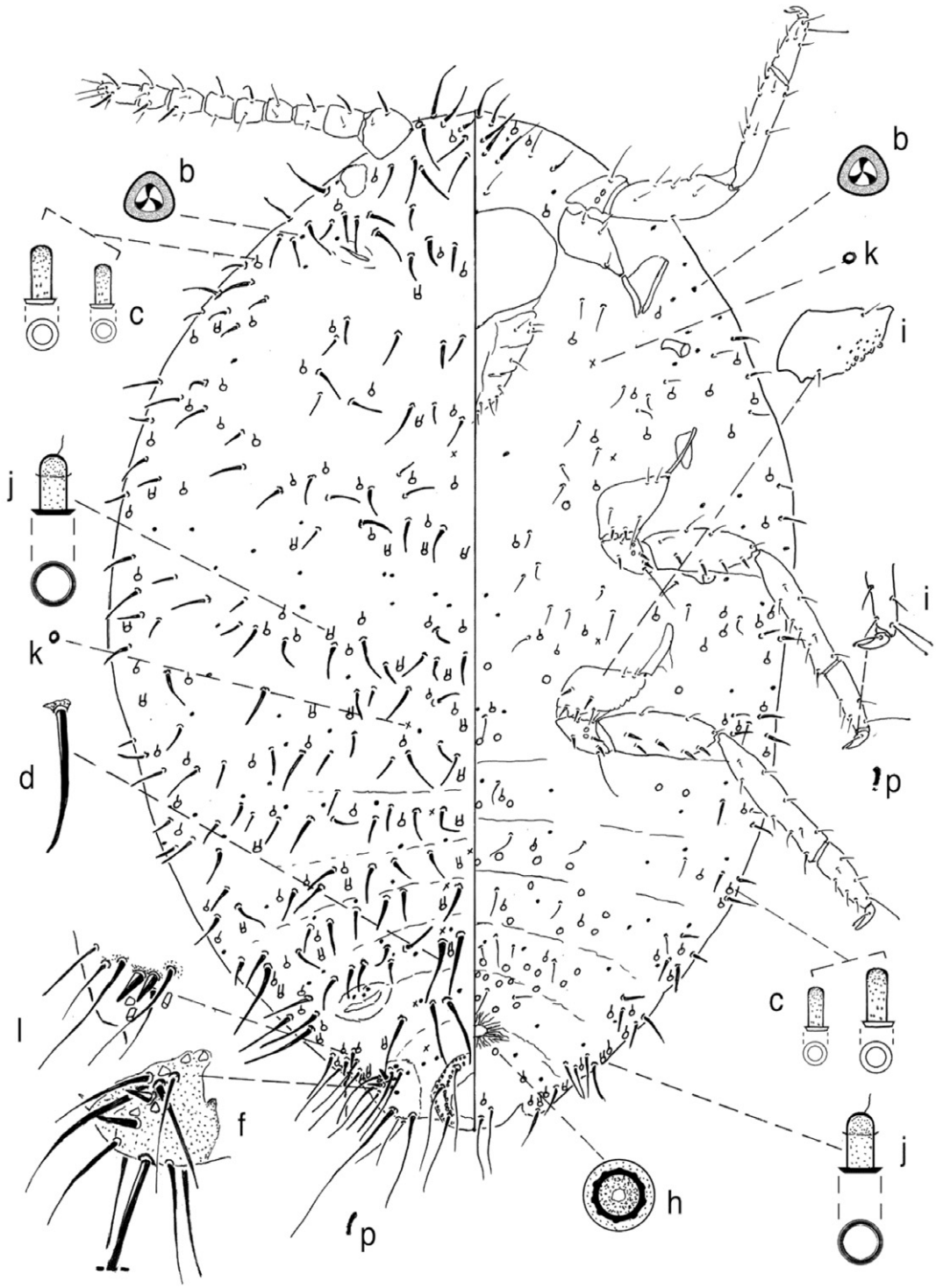

Fig. 9. *Octococcus pentziae*. Adult female. Middelburg, Mpumalanga, South Africa, 9.iv.1963, on *Chrysocoma tenuifolia*, P. Hugo.

times present over surface that look like deformed ducts but much smaller with no consistent shape. Enlarged setae only slightly enlarged, conspicuously longer and narrower than conical setae in cerarii, usually straight or slightly curved, becoming shorter and less enlarged anteriorly, not forming medial cerarii. Without clearly differentiated body setae, longest seta on segment VII 51–95 μm long, with nine to 16 setae on segment VI between lateral margins of posterior ostioles. Longest anal-ring seta 67–161 μm long, 1.1–2.0 times greater than width of anal ring. Ostioles small and inconspicuous, with zero to four loosely associated trilocular pores on anterior lip; anterior ostioles often present, inconspicuous. Eye diameter about same size as length of second antennal segment, usually (but not always) located on dorsum along with antenna.

Venter. Vulva located in normal position. Multilocular pores present from prothorax, mesothorax, metathorax, or segment I to posterior apex of abdomen, submarginal pores absent. Trilocular pores uncommon, rare in medial areas, more abundant laterally. Discoidal pores in small numbers near legs. Oral rims similar to those on dorsum; larger size in lateral areas of segments VII and/or VIII; medium and smaller sizes rare or absent in medial areas of posterior abdominal segments, scattered elsewhere. Unusual sclerotisations, when present, scattered over most of surface. Labium 107–142 μm long. Antenna 195–350 μm long, eight- or usually nine-segmented. Hind coxa with eight to 43 translucent pores, without similar pores on derm adjacent to hind coxa, tibia with zero to six translucent pores; femur with seven to 10 setae, tibia with six to 16, tarsus with eight to 11 setae; coxa with two to four setae noticeably larger than other leg setae, trochanter with three such setae, femur with three to five such setae; tarsal and claw digitules with slightly enlarged apices, tarsal digitules on front leg with only one clubbed seta; claw usually with small denticle. Hind femur + trochanter 134–200 μm long, tibia 92–177 μm long, hind tarsus 60–92 μm long, tibia/tarsus 1.5–2.0. Without small pores on derm adjacent to hind coxa.

Notes. This species is most similar to *O. warniae* by having narrow enlarged setae and by lacking dorsal multilocular pores. *Octococcus pentziae* differs by having (character states in brackets are those of *O. warniae*): few large-sized oral-rim tubular ducts, segment IV with two to five such ducts (many large-sized oral-rim tubular ducts, segment IV with 12–19 such ducts); large-sized oral-rim tubular ducts in incomplete transverse rows across abdominal segments (complete rows); with three to five suranal setae (seven to 12 setae).

Octococcus warniae Miller & Giliomee **sp. n.**, Figs 10–12

Etymology. The specific epithet is named in honour of Warnia Giliomee in recognition of her tolerance and encouragement of her husband's dedication to the study of scale insects. She was present when the type series was collected.

Type material. Holotype adult female is mounted with three other adult females and is the second from the right when viewing the slide with the labels right-side up and with the naked eye. The holotype is deposited in SANC. Left label 'Betty's Bay, Western/ Cape Province S. Africa/ ex: on leaves of/ Metalasia sp., #10/ 10 Nov. 2007/ J.H. Giliomee &/ D.R. Miller/ Balsam.' Right label 'Octococcus/ warniae/ Miller & /Giliomee/ HOLOTYPE/ 3 paratypes.' In addition there are two other slides with the same data as the holotype each containing three paratypes; all are adult females with the exception of one third-instar female (USNM) and one aberrant specimen without anal lobes and with deformed antennae. In addition there are 17 adult female paratypes from 11 different collections given as follows: SOUTH AFRICA: Specific locality unknown, 14.vii.2008, on *Metalasia muricata*, B. Ramirez, 1/1 ad fem. (USNM. APHIS #LA218087). Eastern Cape province: Jeffrey's Bay, 17.iii.1970, on *Metalasia muricata*, P. Insley, 1/1 ad. fem. (SANC 4390-1); Jeffrey's Bay, 12.i.1979, on *Metalasia* sp., S. Neser, 1/1 ad. fem. (SANC 5605-1); Western Cape province: Betty's Bay, 10.xi.2007, on leaves of *Metalasia* sp., J.H. & W. Giliomee & D.R. Miller, 10/9 ad. fem., one third-instar fem. (SANC, USNM); Betty's Bay, 14.iii.2014, on leaves and flower heads of *Metalasia* sp., J.H. & W. Giliomee, B.D. Denno & D.R. Miller, 9/1 first instar, six second instar sex undetermined, one third-instar fem. (SANC, USNM); Cape Point, 24.xi.1964, on *Metalasia* sp., G. De Lotto, 2/2 ad. fem. (SANC 2297 1–2); Cape Town, 9.vi.1978, on *Metalasia muricata*, collector ?,2/2 ad. fem. (SANC 5448 1–2); Franschhoek Pass, 18.xii.1978, on *Metalasia* sp., S. Neser, 1/1 ad. fem. (SANC 5678-1); Simonstown, 7.vii.1962, on *Metalasia muricata*, J. Munting, 1/1 ad. fem. (SANC 675-1); Stellenbosch, Ida's Valley, 27.vii.1936, on

Athanasia trifurcata, C.J. Joubert, 1/1 ad. fem. not a paratype (USNM); Stellenbosch, 27.vii.1937 & 10.viii.1938, on *Athanasia trifurcata*, T.G. Morris & C.J. Joubert, 6/6 ad. fem. (SANC 676 1–2 & 692 1–4); Stellenbosch, 28.xi.1964, on *Pentzia* sp., J. Munting, 1/1 ad. fem. (SANC 949-1); Stellenbosch, 20.v.1977, on *Metalasia* sp., S. Neser, 1/1 ad. fem. (SANC 5283).

Field characters. On the foliage and flower heads of the *Metalasia* host, a shrub in the Asteraceae. Adult female dark grey or black, enclosed in a white sac. First instars are the same colour as the adult female; with one pair of filaments equal in length to about quarter the length of the body; posterior medial wax projection from anal ring about the same length as the filaments; posterior four segments with white wax, the rest of the body is bare.

Adult female (Fig. 10)

Slide-mounted characters. Mounted 1.5 mm long, 1.1 mm wide (1.3–1.5 mm long, 0.9–1.2 mm wide).

Dorsum. Body with posterior segments slightly folded on slide-mounted specimens; cerarii near body margin, not displaced medially; except in very small specimens, anal-lobe area placed on dorsal surface rather than normal position on venter. With two pairs of cerarii; anal-lobe cerarius sclerotised, on prominence, with two conical setae, six (seven or eight) more elongate setae, cluster of 11 (seven to 13) basal trilocular pores. Penultimate cerarius in line with anal-lobe cerarius, with patchy basal sclerotisation, not protruding, with two conical setae, three (three or four) more elongate setae, and basal cluster six (three to five) trilocular pores. Anal-lobe area normally on dorsum but at apex of venter on small specimens, sclerotised, contiguous with anal-lobe cerarius, with four (five to eight) long setae, longest about 170 (158–178) μm long. Suranal setae near apex of abdomen, longest sometimes touching anal ring, with 10 (seven to 12) setae of various lengths. Trilocular pores scattered over surface, most abundant in cerarii and near base of dorsomedial enlarged setae. Discoidal pores uncommon, when present located in medial areas of thorax and anterior abdominal segments. Oral rims of three sizes, larger size distinct, medium and small sizes intergrading: larger size barrel-shaped with narrow rim, present laterally from head or prothorax to segments VII or VIII, present in medial areas from prothorax to segments VI or VII, forming distinct transverse rows across abdominal segments, with 18 (12–19) ducts on segment IV; medium and small ducts narrow and elongate, with large rim, of same distribution pattern as large ducts, but abundant on head. Unusual sclerotisations present over surface that look like deformed ducts but much smaller with no consistent shape. Enlarged setae conspicuously longer and narrower than conical setae in cerarii, often curved, becoming shorter and less enlarged anteriorly, not forming medial cerarii. Without clearly differentiated body setae, longest seta on segment VII about 80 (57–88) μm long, with 12 (11–14) setae on segment VI between lateral margins of posterior ostioles. Longest anal-ring seta 160 (138–175) μm long, 1.6 (1.3–1.6) times greater than width of anal ring. Ostioles small and inconspicuous, posterior ostioles with three (two to four) loosely associated trilocular pores on anterior lip; without anterior ostioles. Eye diameter about same size as length of second antennal segment, located on dorsum along with antenna.

Venter. Vulva located in normal position. Multilocular pores present from prothorax or mesothorax to posterior apex of abdomen, submarginal pores absent. Trilocular pores uncommon, rare in medial areas, more abundant laterally. Discoidal pores present near legs. Oral rims similar to those on dorsum; larger size in lateral areas of segments VI, VII, and VIII; medium and smaller size rare or absent in medial areas of posterior abdominal segments, scattered elsewhere. Unusual sclerotisations present over most of surface. Labium 115 (112–115) μm long. Antenna 285 (260–300) μm long, eight-segmented. Hind coxa with 53 (41–65) translucent pores, tibia with three (zero to five) translucent pores; femur with nine (eight or nine) setae, tibia with eight (seven or eight) setae; coxa with two (one to three) setae noticeably larger than other leg setae, trochanter with three (two or three) such setae, femur with four (three or four) such setae; tarsal and claw digitules with slightly enlarged apices, tarsal digitules on front leg with only one clubbed seta; claw usually without denticle, rarely with slight swelling near apex. Hind femur + trochanter 190 (170–190) μm long, tibia 125 (118–135) μm long, hind tarsus 85 (78–85) μm long, tibia/tarsus 1.5 (1.4–1.7). Without small pores on derm adjacent to hind coxa.

Notes. This species is most similar to *O. pentziae;* for a comparison of these species see the notes section of *O. pentziae*. This is the only species that has been intercepted at United States ports-of-

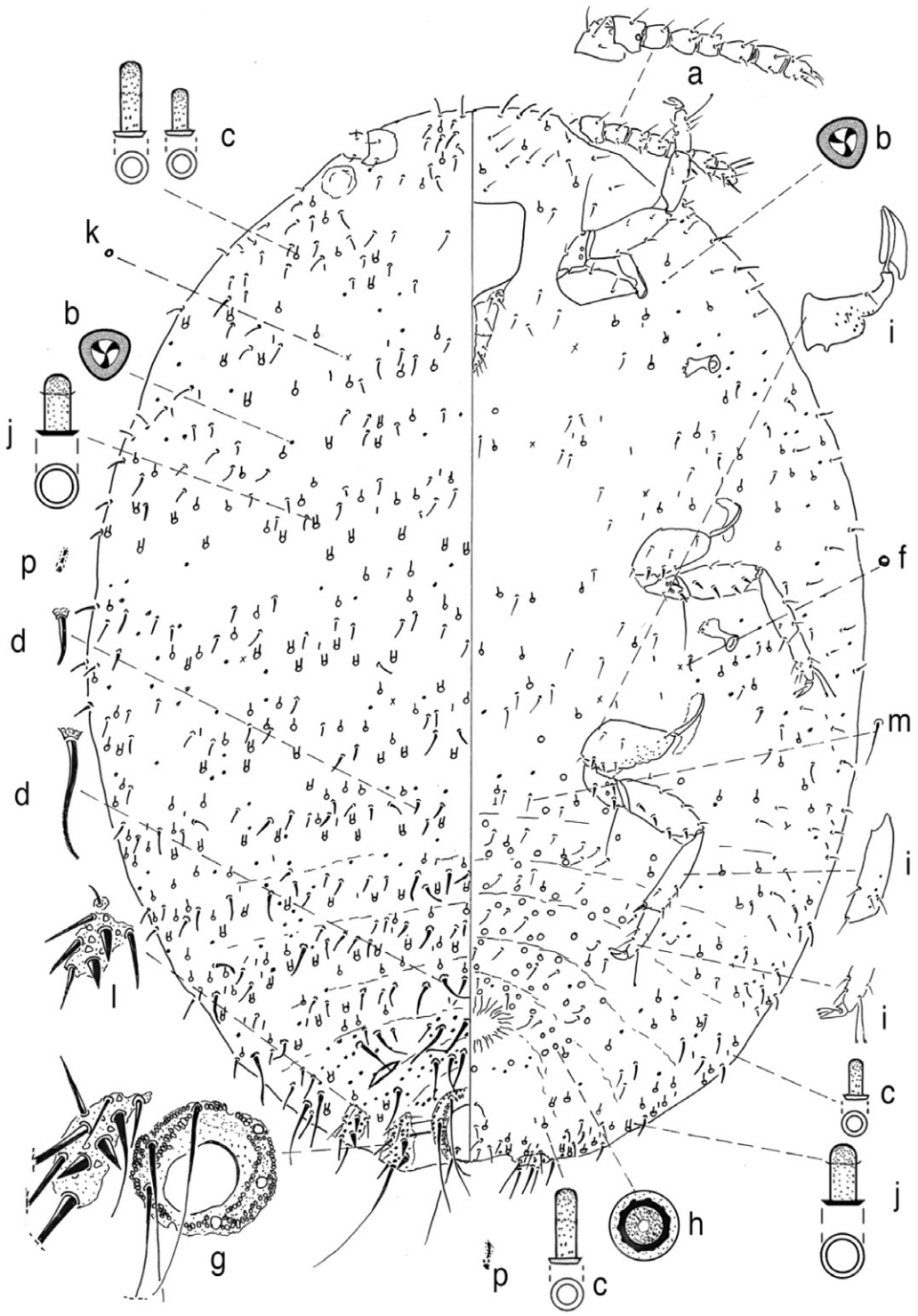

Fig. 10. *Octococcus warniae*. Adult female. Betty's Bay, Western Cape, South Africa, 10.xi.2007, on leaves of *Metalasia* sp., J.H. & W. Giliomee & D.R. Miller.

entry. Because the *Metalasia* host is a member of the Asteraceae and because this plant family contains many environmentally and economically important plants, it is important to be vigilant about keeping this mealybug from becoming established outside of its normal geographic range.

Third-instar female (Fig. 11)

Slide-mounted characters. Mounted 0.8 mm long, 0.6 mm wide.

Dorsum. Body with posterior segments normal, not folded on slide-mounted specimens; cerarii near body margin, not displaced medially; anal-lobe area at apex of abdomen mostly on dorsal surface. With two pairs of cerarii; anal-lobe cerarius sclerotised, on prominence, with two conical setae, four more elongate setae, cluster of four or five basal trilocular pores. Penultimate cerarius in line with anal-lobe cerarius, with basal sclerotisation, not protruding, with two conical setae, two more elongate setae, and basal cluster of two trilocular pores. Anal-lobe area at apex of abdomen, contiguous with anal-lobe cerarius, with three long setae, longest 120 μm long. Suranal setae near apex of abdomen, longest not touching anal ring, with seven setae. Trilocular pores scattered over surface, most abundant posteriorly. Discoidal pores absent. Oral rims of two or three sizes, larger size distinct, medium and small sizes intergrading; larger size barrel-shaped with narrow rim, present laterally from head to segments VII, present in medial areas from prothorax to segment VI, with eight ducts on segment IV; medium and small ducts narrow and elongate, with large rim, of same distribution pattern as large ducts, but rare on head and posterior abdominal segments. Unusual sclerotisations present over surface that look like deformed ducts but much smaller with no consistent shape. Enlarged setae conspicuously longer and narrower than conical setae in cerarii, often curved, becoming shorter and less enlarged anteriorly, not forming medial cerarii. Without clearly differentiated body setae, longest seta on segment VII about 45 μm long, with six setae on segment VI between lateral margins of posterior ostioles. Longest anal-ring seta 120 μm long, 2.2 times greater than width of anal ring. Posterior ostioles small and inconspicuous, with one seta and two or three loosely associated trilocular pores on anterior lip; anterior ostioles absent. Eyes about same size as basal antennal segment, located on dorsum along with antenna.

Venter. With one multilocular pore present on segment VI. Trilocular pores scattered over surface, rare or absent in medial areas of thorax. Discoidal pores absent. Oral rims similar to those on dorsum, larger size in lateral areas of segments VII, medium and smaller size rare or absent in medial areas of posterior abdominal segments, scattered elsewhere, absent from head. Unusual sclerotisations most abundant near body margin. Labium 88 μm long. Antenna 198 μm long, seven-segmented. Legs without translucent pores, femur with nine setae, tibia with seven setae, coxa with two setae noticeably larger than other leg setae, trochanter with three such setae, femur with four such setae, tarsal and claw digitules with slightly enlarged apices, tarsal digitules on front leg with only one clubbed seta, claw without denticle. Hind femur + trochanter 118 μm long, tibia 68 μm long, hind tarsus 68 μm, tibia/tarsus 1.0. Without small pores on derm adjacent to hind coxa.

Notes. This description is based on two specimens from one locality.

First-instar nymph (Fig. 12)

Slide-mounted characters. Mounted 0.5 mm long, 0.3 mm wide.

Dorsum. Body with posterior segments normal, not folded; cerarii near body margin, not displaced medially; anal-lobe area at apex of abdomen, mostly on dorsal surface. With two pairs of definite cerarii, additional five or six pairs of elongate setae present forward to anterior abdominal segment; anal-lobe cerarius sclerotised, not on prominence, with two conical setae about equal in size, no auxiliary seta, with one basal trilocular pore. Penultimate cerarius in line with anal-lobe cerarius, with basal sclerotisation, not protruding, with two conical setae about equal in size, no auxiliary setae, and with one basal trilocular pore. Suranal setae near apex of abdomen, longest close to anal ring, with four setae. Trilocular pores present in submedial area of mesothorax, metathorax, segments I, VII, and VIII, in marginal or submarginal areas of head, prothorax, mesothorax, and segments II–VIII. Discoidal pores absent. Oral rims absent. Unusual sclerotisations absent. Enlarged setae of one size, more elongate and thinner than conical setae in cerarii, becoming shorter and less enlarged anteriorly, not forming conspicuous medial cerarii, longest conical seta on segment VI 28 μm long; with enlarged setae only,

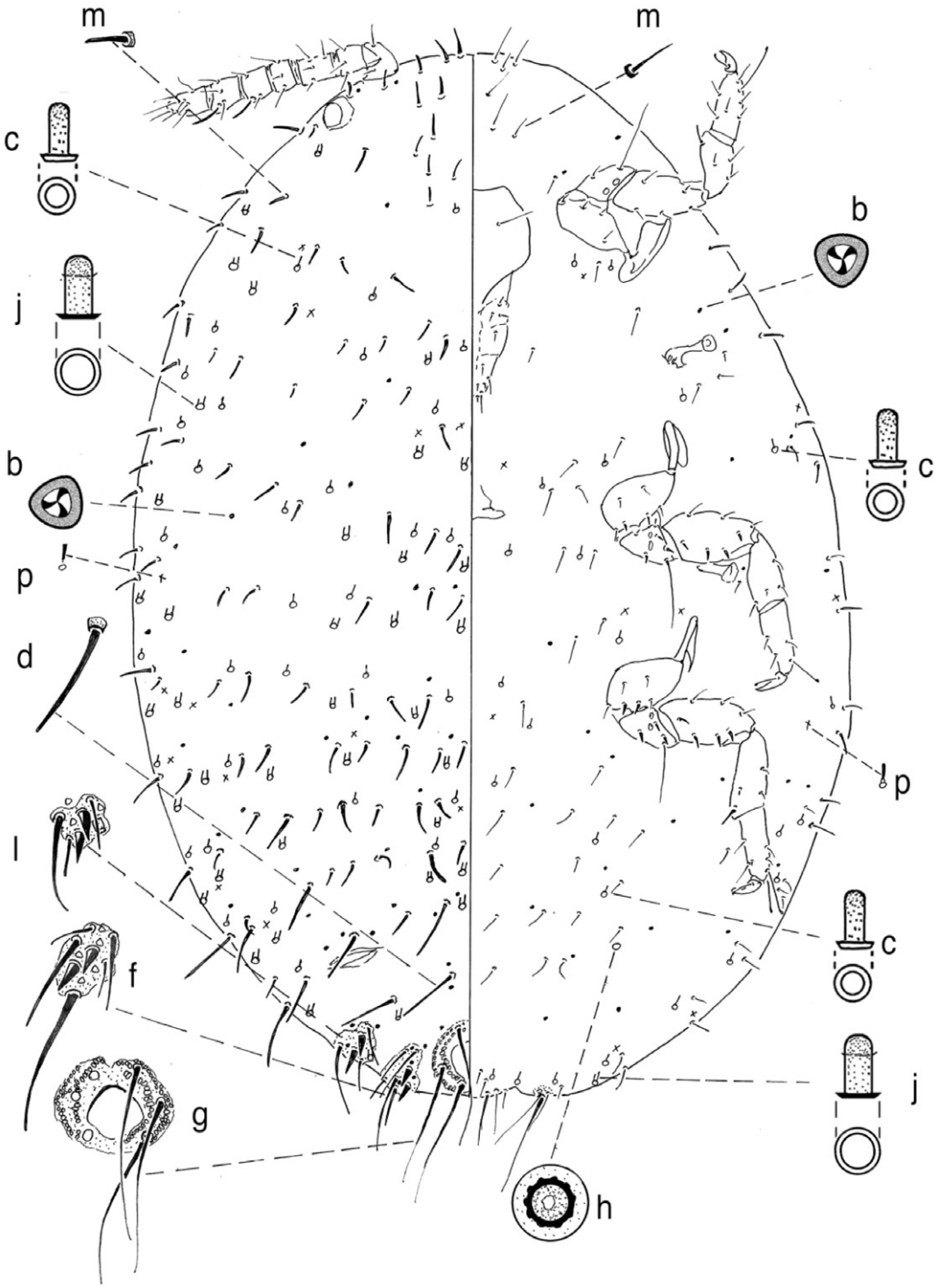

Fig. 11. *Octococcus warniae*. Third-instar female. Betty's Bay, Western Cape, South Africa, 10.xi.2007, on leaves of *Metalasia* sp., J.H. & W. Giliomee & D.R. Miller.

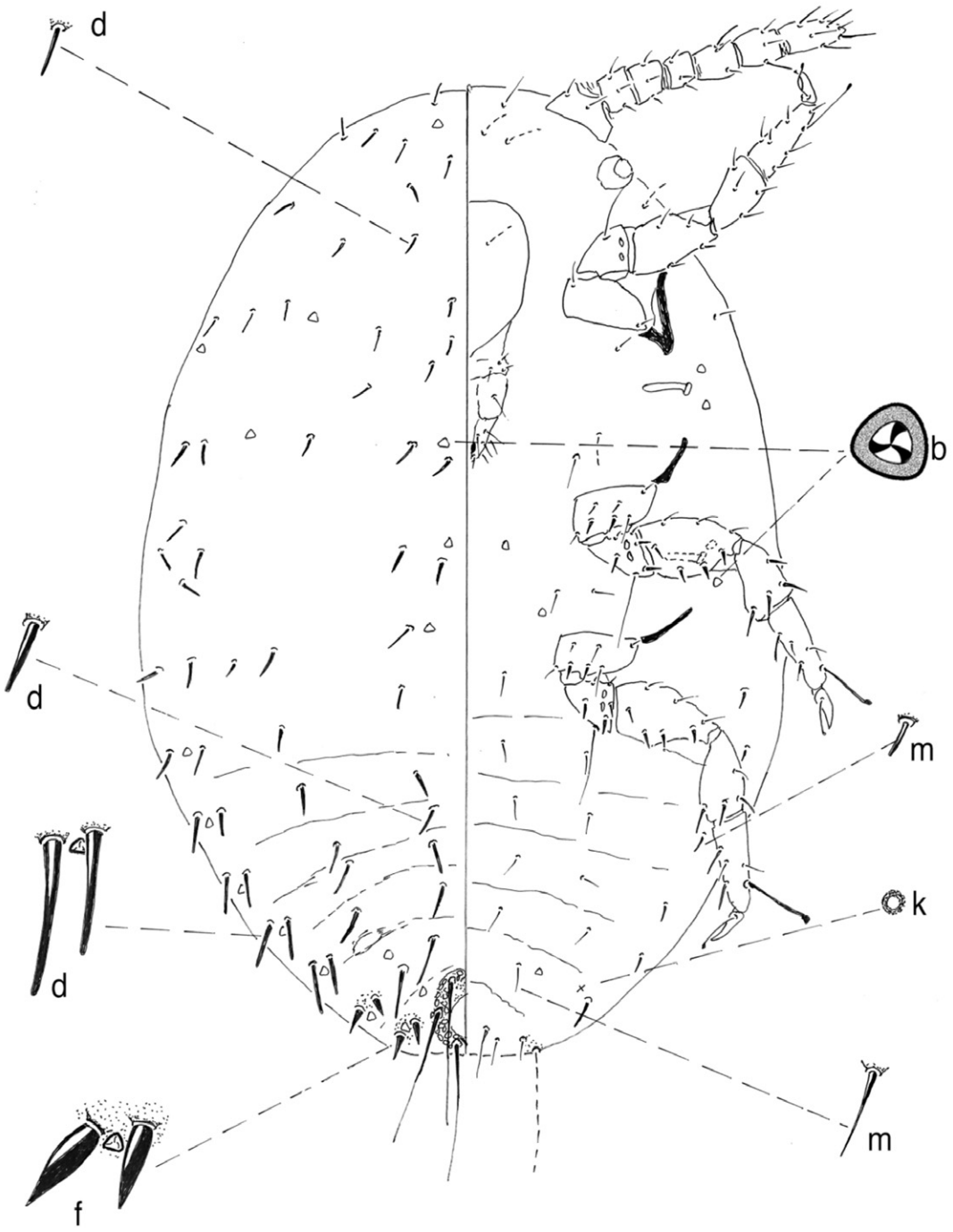

Fig. 12. *Octococcus warniae*. First instar. Betty's Bay, Western Cape, South Africa, 14.iii.2014, on leaves of *Metalasia* sp., J.H. & W. Giliomee, B.D. Denno & D.R. Miller.

without body setae. With four setae on segment VI between lateral margins of posterior ostioles. Longest anal-ring seta 57 μm long, 1.4 times greater than width of anal ring. Posterior ostioles inconspicuous, with one seta and no trilocular pores on anterior lip; anterior ostioles absent. Eyes smaller than basal antennal segment, located on body margin.

Venter. Without multilocular pores. Trilocular pores usually present submarginally on segment VII, submedially on meso- and metathorax, and near anterior and posterior spiracles. Discoidal pores present submarginally on segment VII. Unusual sclerotisations absent. Anal-lobe area at apex of abdomen on venter (not on dorsum as in adult female), with two setae including anal-lobe seta, anal-lobe setae broken. Labium 58 μm long. Antenna 150 μm long, seven-segmented. Legs without translucent pores; femur with seven setae, tibia with six setae; coxa with two seta noticeably more enlarged than other setae, trochanter with three such setae, femur with four such setae; tarsal and claw digitules with slightly enlarged apices, tarsal digitules on front leg with only one clubbed seta; claw without denticle. Hind femur + trochanter 80 μm long, tibia 52 μm long, hind tarsus 52 μm, tibia/tarsus 1.0. Without pores on derm near hind coxa.

Notes. This description is based on a single specimen. This species is most similar to *O. africanus*. For a comparison see the notes section of that species.

Octococcus salsolicola (Priesner & Hosny), *nomen dubium*

Ripersia salsolicola Priesner & Hosny, 1935: 114 (original designation).

Octococcus salsolicola; Ezzat 1962: 163 (change of combination); Abd-Rabu 2001: 1362; Ben-Dov 1994: 259; Ezzat & Nada 1987: 89; Mohammad & Ghabbour 2008: 155.

This species was described from specimens collected on *Salsola foetida* (Chenopodiaceae) near the shore of the Red Sea in Egypt. Ezzat (1962) could not locate specimens in the scale collection of the Egyptian Ministry of Agriculture where they should have been deposited. A single poorly prepared specimen is deposited in The Natural History Museum in London and was examined by D.J. Williams at the request of Ezzat in the early 1960s. His conclusion was that it has some relation to the genus *Octococcus*. Based on William's conclusion Ezzat (1962) moved the species to *Octococcus* because it clearly was misplaced in *Ripersia*. The generic affinities of the species are not clear, but it seems unlikely that it is properly placed in *Octococcus*. Based on the original description and illustration it appears that the dorsal setae are either not enlarged or only slightly enlarged, the setae on the hind legs are all approximately of the same thickness, there are no translucent pores on the hind coxa, and the antennae are seven-segmented with only a slight indication of a division of the distal segment. There apparently are no trilocular pores and there is no indication that there are oral-rim tubular ducts. The wax covering is said to be very thin and it occurs on a non-asteraceous host in North Africa. All of these character states are inconsistent with species of *Octococcus*. We are here treating this species as a *nomen dubium* since the original type series has been lost or destroyed and the description is insufficient to place it. Perhaps someone will recollect the species in the future.

The BMNH specimen mentioned above was remounted, but it was either overcooked or completely lost in the process. We have examined the residue that is mounted on a slide in The Natural History Museum in London, but there are six fragments that appear to be artefacts of some sort with no recognisable structures. It is not even clear that the fragments are parts of the original specimen.

Key to species of *Octococcus* (adult females)

1 At least some dorsal setae conical or lanceolate 2
— Dorsal setae enlarged but not conical or lanceolate 4
2(1) Dorsal multilocular pores present 3
— Dorsal multilocular pores absent . . . . . *africanus* (Brain)
3(2) Anal-lobe cerarius with two or three conical setae; abdominal segment IV with fewer than seven large-sized oral-rim tubular ducts . . . . . *minor* De Lotto
— Anal-lobe cerarius with more than three conical setae; abdominal segment IV with more than seven large-sized oral-rim tubular ducts . . . . . *barbarae* Miller & Giliomee
4(1) With two pairs of distinct cerarii; without dorsomedial cerarii 5

— With more than two pairs of cerarii; often with dorsomedial cerarii . . . . . *gullanae* Miller & Giliomee

5(4) More than 10 large-sized oral-rim tubular ducts on abdominal segment IV; seven to 10 suranal setae . . *warniae* Miller & Giliomee

— Less than nine large-sized oral-rim tubular ducts on abdominal segment IV; three to five suranal setae . . . . . *pentziae* Hall

Key to species of *Octococcus* (first-instar nymphs)

1 Dorsal abdominal trilocular pores present in submarginal line 2

— Dorsal abdominal trilocular pores absent or restricted to cerarii . . . . . *africanus* (Brain)

6(1) Four pairs of cerarii; cerarian trilocular pores tubular, longer than wide . . . . . *minor* De Lotto

— Two pairs of cerarii; cerarian trilocular pores sessile, wider than long . . . . . *warniae* Miller & Giliomee

CONCLUSIONS

Many more collections of *Octococcus* mealybugs have been made since work on this genus by De Lotto (1958, 1969, 1977). In the present study, all available specimens of *Octococcus* have been examined, allowing the recognition of three new species that are described and illustrated herein. Three of the four named species (*O. africanus*, *O. minor* and *O. pentziae*) are redescribed and illustrated. The status of *O. salsolicola* is reassessed. Several immature stages are described for the first time and keys to species are provided.

It is of interest that all immatures of *Octococcus*, with the exception of the first-instar nymph, possess tubular ducts. It is reasonable to believe that each of these life stages produces a thick waxy covering similar to the covering of the adult female. Species of both *Hypogeococcus* and *Trabutina* also possess tubular ducts in the immature stages, excluding the first-instar nymph, and most likely also produce a wax covering similar to the adult female. It is likely that other members of the Trabutinini have similar habits and morphology.

It is surprising that the known first-instar nymphs of *Octococcus* species all have seven-segmented antennae. We looked at the first-instar nymphs of several other members of the Trabutinini based on Hardy *et al*. (2008) (including *Amonostherium*, *Antonina*, *Balanococcus*, *Nipaecoccus*, *Melanococcus*, *Miscanthococcus* and *Peridiococcus*), but found none that have seven-segmented antennae.

A summary of the distribution and host information is as follows: *O. africanus* Northern Cape and Western Cape on *Elytropappus* (Asteraceae), *Stoebe* (Asteraceae), and *Tamarix* (Tamaricaceae); *O. barbarae* Western Cape on *Oedera* (Asteraceae); *O. gullanae* Northern Cape and Western Cape on *Lampranthus* (Aizonaceae) and 'mesem' (Aizonaceae); *O. minor* Free State, Mpumalanga, Northern Cape, and Western Cape on *Chrysocoma* (Asteraceae), *Nolletia* (Asteraceae), *Pteronia* (Asteraceae), *Rosenia* (Asteraceae), and *Stoebe* (Asteraceae); *O. pentziae* Eastern Cape, Mpumalanga, and Northern Cape on *Chrysocoma* (Asteraceae), *Pentzia* (Asteraceae), and *Ursinia* (Asteraceae); *O. warniae* Eastern Cape and Western Cape on *Athanasia* (Asteraceae), *Metalasia* (Asteraceae), and *Pentzia* (Asteraceae),

All species of *Octococcus* are restricted to South Africa and all but one is recorded on hosts in the Asteraceae. The *Tamarix* record of *O. africanus* is strongly suspected to be a misidentification of *Elytropappus*. *Octococcus gullanae* is the one species that is not found on the Asteraceae being restricted to the succulent family Aizoaceae. Of all the species in *Octococcus*, *O. gullanae* seems to be the most distinct with dorsomedial cerarii, more than two pairs of cerarii, and no distinct large-sized enlarged oral-rim tubular ducts. Geographically some species seem to be more prevalent in certain parts of South Africa than in others. *Octococcus africanus*, *O. barbarae*, and *O. gullanae* are mostly western; *O. minor* tends to be more northern but there is one record from the southern part of the Western Cape; *O. pentziae* is more widespread; and *O. warniae* is restricted to the southern provinces.

ACKNOWLEDGEMENTS

We are especially indebted to P. Gullan, Australian National University, for mounting and allowing us to study the many *Octococcus* specimens that she collected in South Africa. She also provided us with the image of adult females and first-instar nymphs of *O. africanus* and provided a detailed and extremely useful review of the manuscript. Her suggestions have greatly improved the final document. We are most grateful to I. Millar for acting as host while the first author worked in the South African National Collection in Pretoria. He

was especially accommodating in allowing the author to work in his laboratory and in permitting him to borrow and study the wonderful collection of South African mealybugs. He also reviewed the manuscript and many of his suggestions are incorporated here. We give special thanks to G. Venable of PXL PWR, Beltsville, Maryland, U.S.A., who spent considerable time and effort enhancing the final line-drawing images. We give thanks to E. Marinus, The Compton Herbarium, Kirstenbosch for arranging the identification of several of the plant hosts by the relevant specialists. We also are grateful to P. Brown of The Natural History Museum in London for selecting and loaning us *Octococcus* specimens from the collection and to I. Stocks, P. Skelly, and G. Hodges, Department of Plant Industry, for allowing the first author to work and study in the Florida State Collection of Arthropods in Gainesville, Florida. Thanks to N. Hardy for providing a copy of his morphological data matrix used in the paper Hardy *et al*. (2008). We also are grateful to M. Dornberg for preparing several of the *Octococcus* specimens collected during our trip to South Africa in 2014. The first author could never give enough accolades to B. Denno for her major and significant contribution to this and many other scale-related works. She has provided crucial information technology support in addition to undaunted encouragement, suggestions, and assistance whenever they are needed. The USDA is an equal opportunity provider and employer.

REFERENCES

ABD-RABOU, S. 2001. Parasitoids attack mealybugs (Homoptera: Coccoidea: Pseudococcidae) in Egypt. *Egyptian Journal of Agricultural Research* **79**: 1355–1376.

AFIFI, S. 1968. Morphology and taxonomy of the adult males of the families Pseudococcidae and Eriococcidae (Homoptera: Coccoidea). *British Museum* (*Natural History*), *2nd Report on Economic Zoology* **13**: 3–210.

AFIFI, S. & KOSZTARAB, M. 1967. Studies on the morphology and taxonomy of the males of *Antonina* and one related genus (Homoptera: Coccoidea, Pseudococcidae). *Research Division Bulletin*, *Virginia Polytechnic Institute and State University* **15**: 1–43.

BEN-DOV, Y. 1994. *A Systematic Catalogue of the Mealybugs of the World* (*Insecta: Homoptera: Coccoidea: Pseudococcidae and Putoidae*) *with Data on Geographical Distribution*, *Host Plants*, *Biology and Economic Importance*. Intercept Limited, Andover, U.K.

BRAIN, C.K. 1915. The Coccidae of South Africa. *Transactions of the Royal Society of South Africa* **5**: 65–194.

DANZIG, E.M. & MILLER, D.R. 1996. A systematic revision of the mealybug genus *Trabutina* (Homoptera: Coccoidea: Pseudococcidae). *Israel Journal of Entomology* **30**: 7–46.

DE LOTTO, G. 1958. The Pseudoccoidae (Hom.: Coccoidea) described by C.K. Brain from South Africa. *Bulletin of the British Museum* (*Natural History*) *Entomology*, *Supplement* **7**: 79–120.

DE LOTTO, G. 1969. The mealybugs of South Africa (Homoptera: Pseudococcidae), II. *Entomology Memoirs*, *Department of Agricultural Services*, *Republic of South Africa* **20**: 1–30.

DE LOTTO, G. 1977. On some African mealybugs (Homoptera: Coccoidea: Pseudococcidae). *Journal of the Entomological Society of Southern Africa* **40**: 13–36.

EZZAT, Y.M. 1962. A synopsis of the family Pseudococcidae as known in Egypt, U.A.R. *Bulletin de la Société Entomologique d'Egypte* **46**: 155–170.

EZZAT, Y.M. & McCONNELL, H.S. 1956. A classification of the mealybug tribe Planococcini (Pseudococcidae: Homoptera). *Bulletin of the Maryland Agriculture Experiment Station* A-e84: 1–108.

EZZAT, Y.M. & NADA, S.M.A. 1987 (1986). List of superfamily Coccoidea as known to exist in Egypt. *Bolletino del Laboratorio de Entomologia Agraria 'Filippo Silvestri'* **43** (Supplement): 85–90.

FERRIS, G.F. 1918. The California species of mealy bugs. Stanford University Publications, University Series. Palo Alto, CA, U.S.A.

GILIOMEE, J.H. 1966. A list of South African scale insects (Homoptera; Coccoidea) in the collection of the British Museum (Natural History) with information on their host plants and distribution. *Annale Universiteit van Stellenbosch* **41**: 414–428.

HALL, W.J. 1939. A new genus and four apparently new species of Coccidae (Homoptera) from the Union of South Africa. *Journal of the Entomological Society of Southern Africa* **2**: 93–100.

HARDY, N.B., GULLAN, P.J. & HODGSON, C.J. 2008. A subfamily-level classification of mealybugs (Hemiptera: Pseudococcidae) based on integrated molecular and morphological data. *Systematic Entomology* **33**: 51–71.

McKENZIE, H.L. 1967. *Mealybugs of California with Taxonomy*, *Biology*, *and Control of North American Species* (*Homoptera: Coccoidea: Pseudococcidae*), University of California Press, Berkeley, CA, U.S.A.

MILLAR, I.M. 2002. Mealybug genera (Hemiptera: Pseudococcidae) of South Africa: identification and review. *African Entomology* **10**: 185–233.

MILLER, D.R. 1983. Key to North and Central American species of the mealybug genus *Hypogeococcus* (Homoptera: Coccoidea: Pseudococcidae) with description of four new species and redescription of the type species. *Pan-Pacific Entomologist* **59**: 188–217.

MILLER, D.R. 1991. Superfamily Coccoidea. In: Stehr, F.W. (Ed.) *Immature Insects*, Vol. 2. 90–107. Kendall/Hunt Publishing Co., Dubuque, Iowa, U.S.A.

MILLER, D.R. & MILLER, G.L. 1993. A new species of

Puto and a preliminary analysis of the phylogenetic position of *Puto* group within the Coccoidea. *Jeffersoniana: Contributions from the Virginia Museum of Natural History* **4**: 1–35.

MOHAMMAD, Z.K. & GHABBOUR, M.W. 2008. Updating list of the superfamily Coccoidea (Hemiptera) as known to exist in Egypt. *Journal of the Egyptian German Society of Zoology* **56E**: 147–162.

MORRISON, H. & MORRISON, E. 1966. An annotated list of generic names of the scale insects (Homoptera: Coccoidea). *Agricultural Research Service, United States Department of Agriculture, Miscellaneous Publication* No. 1015.

PRIESNER, H. & HOSNY, M. 1935. Brief description of two new mealy bugs. *Bulletin de la Société Entomologique d'Egypte* **28**: 112–115.

WILLIAMS, D.J. 1958. The mealybugs (Pseudococcidae – Homoptera) described by W.J. Hall, F. Laing and A.H. Strickland from the Ethiopian region. *Bulletin of the British Museum* (*Natural History*) *Entomology* **7**: 1–37.

Accepted 17 August 2015